metal finishing

PAINT APPLICATION · ELECTRODEPOSITION · VITREOUS ENAMELLING
GALVANIZING · METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 5 No. 49 (*New Series*) JANUARY, 1959

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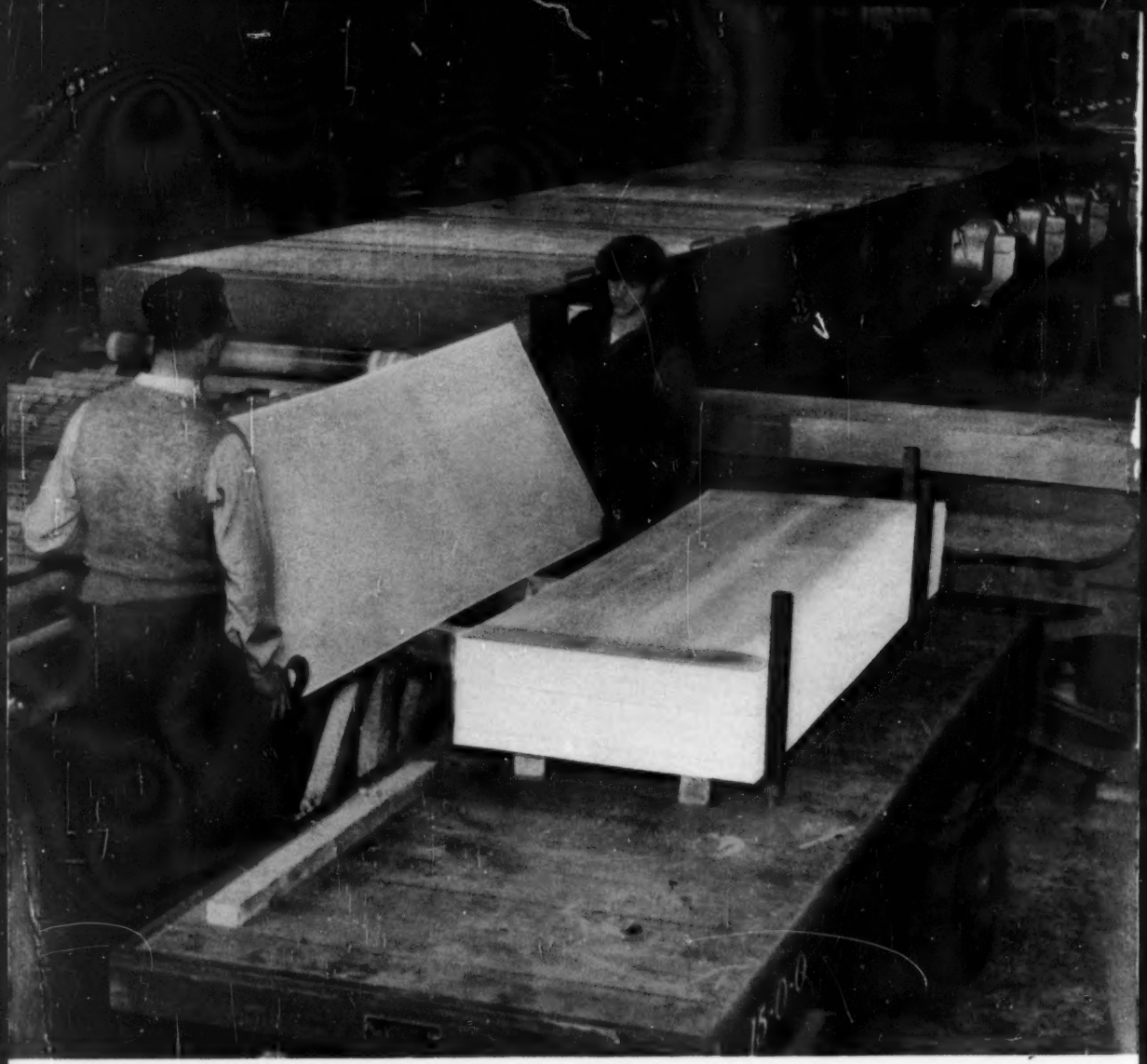

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an electrolytically coated steel sheet

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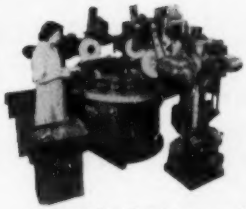
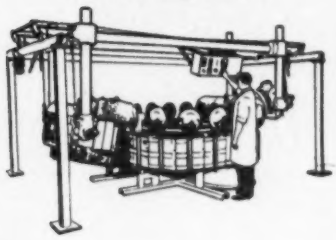
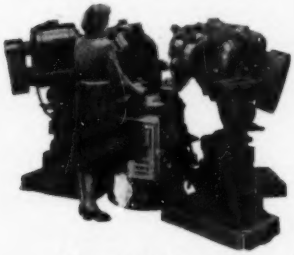


48" diam M/c. (Continuous type).



72" diam. M/c. (Indexing type).



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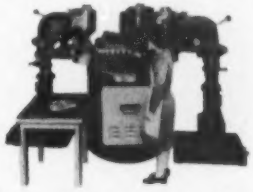
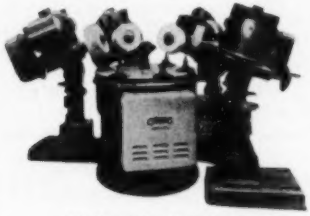
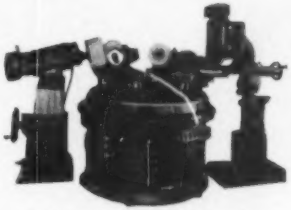


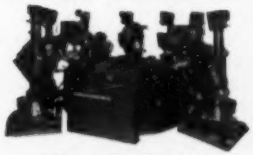
30" diam. M/c. (Continuous type).



30" diam M/c. (Indexing type).



39" diam. M/c. (Indexing type).



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These unit Dust Collectors can be applied to most grinding, polishing, cutting, buffing or abrasive operations on mild steel, cast or malleable irons, non ferrous, alloys, plastics, rubber, ebonite, wood, etc., etc. No special foundations or fixing arrangements are necessary. Where desired castor bases can be fitted.

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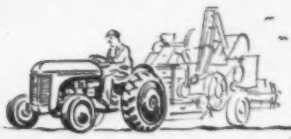

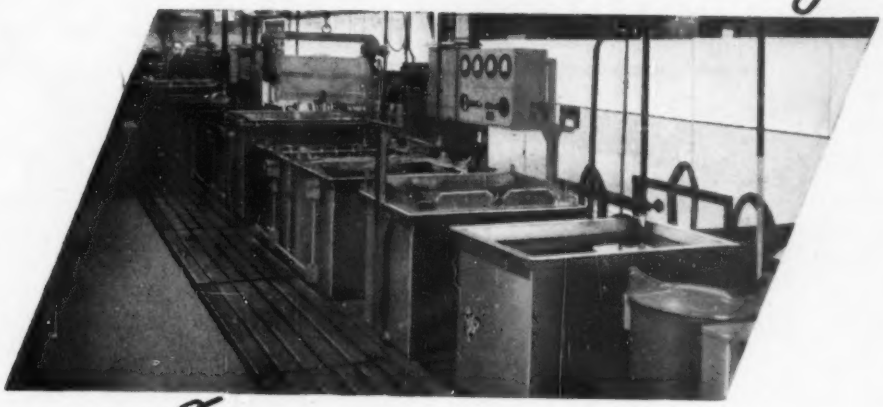

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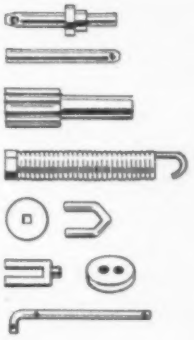

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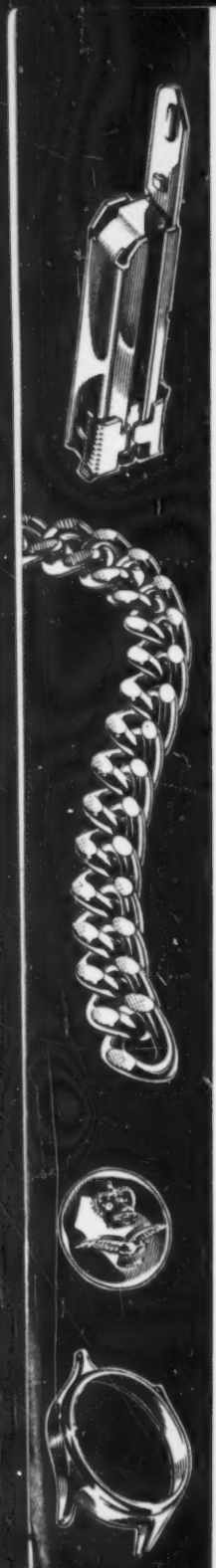

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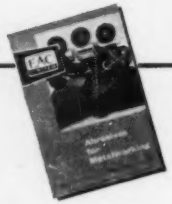

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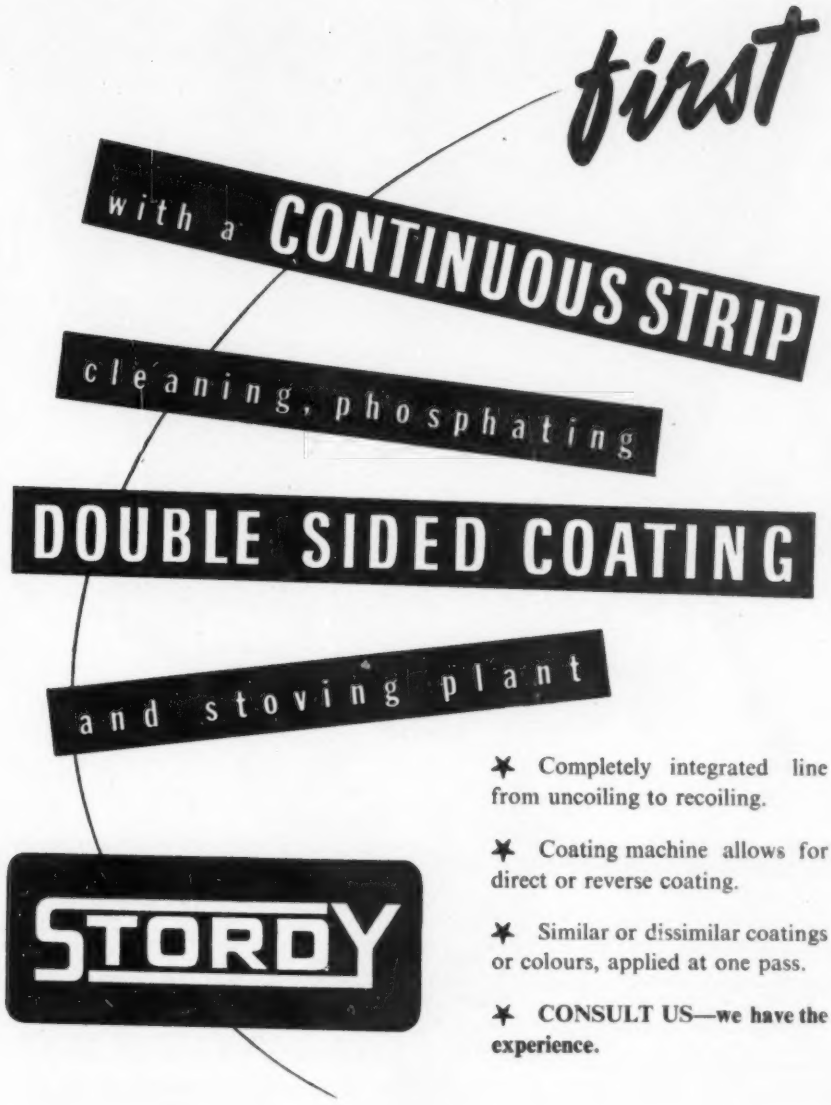

✱ Completely integrated line from uncoiling to recoiling.

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✱ Similar or dissimilar coatings or colours, applied at one pass.

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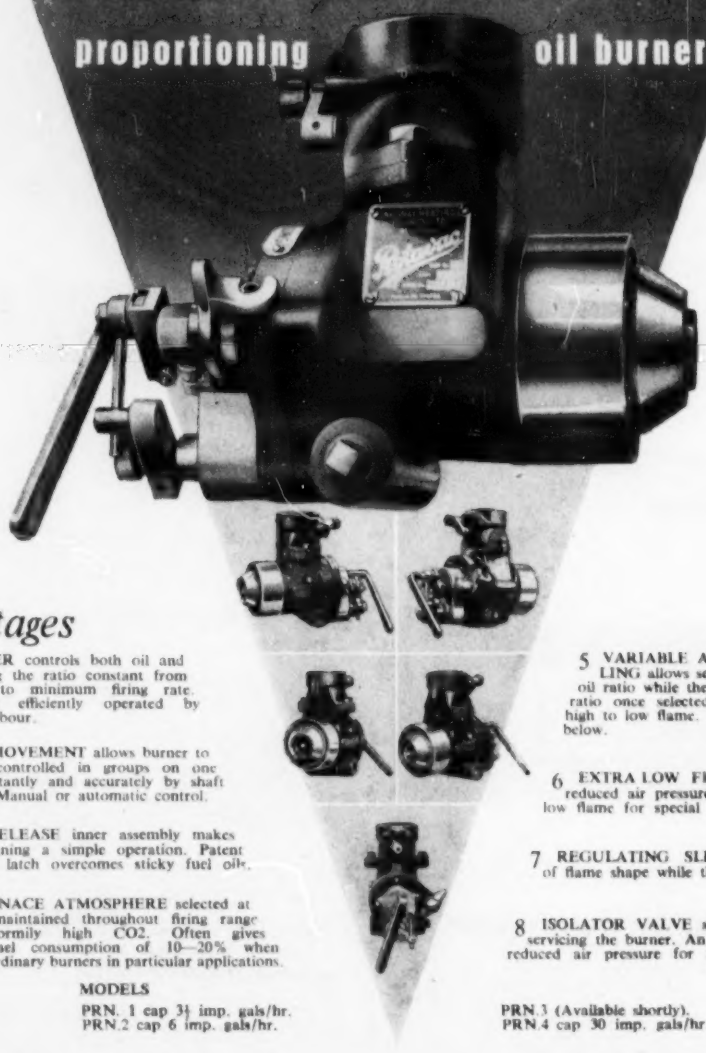

advantages

1 ONE LEVER controls both oil and air, keeping the ratio constant from maximum to minimum firing rate, easily and efficiently operated by unskilled labour.

2 RADIAL MOVEMENT allows burner to be easily controlled in groups on one furnace instantly and accurately by shaft or cable. Manual or automatic control.

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6 EXTRA LOW FLAME SHIELD provides reduced air pressure to give a smaller stable low flame for special applications.

7 REGULATING SLEEVE allows adjustment of flame shape while the burner is in operation.

8 ISOLATOR VALVE shuts off air supply when servicing the burner. An intermediate setting gives reduced air pressure for quicker, simpler lighting.

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PRN. 1 cap 3½ imp. gals/hr.
PRN.2 cap 6 imp. gals/hr.
PRN.3 (Available shortly).
PRN.4 cap 30 imp. gals/hr.

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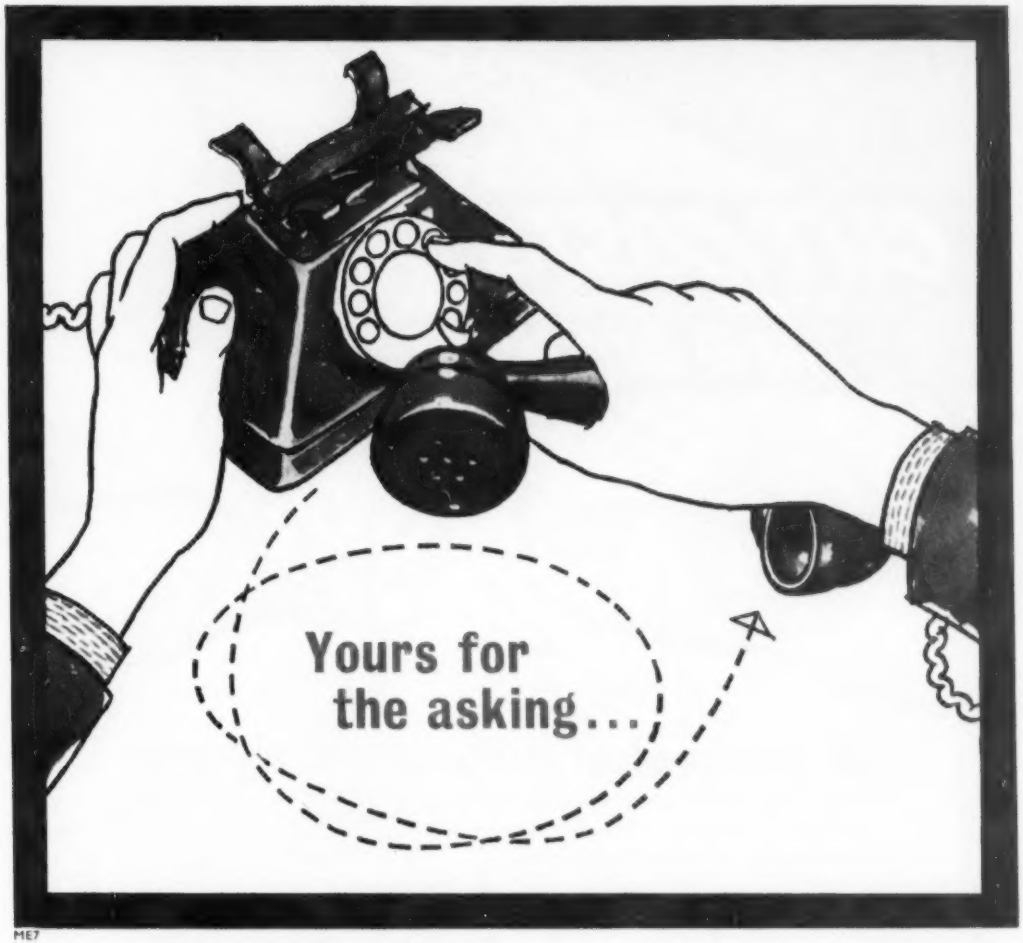

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on your product finishing

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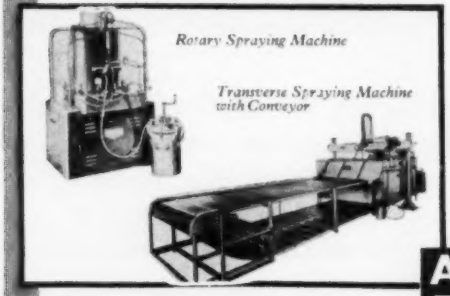

- *Labour costs reduced by the automatic system.*
- *Paint costs drastically cut by paint heating equipment.*

And in addition:

- *Rejects are minimised.*
- *Better, more uniform finish.*

Aerograph-DeVilbiss paint heating equipment is equally economical in automatic and in ordinary spray finishing.

Why not write for full details of Aerograph-DeVilbiss automatic spray and paint heating equipment? Better still, send for an Aerograph-DeVilbiss technical representative who will gladly discuss on the spot how you can save on finishing costs. You are committed to nothing—it is part of the unique free service Aerograph-DeVilbiss are pleased to offer.

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D1893

PORTABLE pH METER CAT. NO. 11071

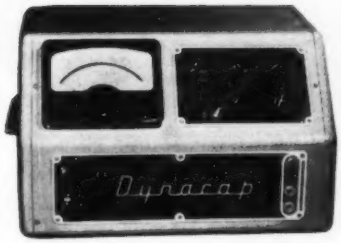
The new Pye Portable pH Meter is completely self-contained, with batteries, direct-reading meter and accessories. The front of the right hand compartment drops down to provide an electrode stand. The sheathed electrode assembly, however, can be carried in the hand when it is required to take on the spot dip tests.

A four valve amplifier with a large degree of negative feedback enables a robust meter movement to be used and provides exceptional linearity and stability of calibration. The input stage uses an electrometer type of valve which reduces errors due to grid current and input conductance to a very low order. All valves are robust sub-miniature types giving maximum immunity from mechanical shock and very low power consumption. Consumption is balanced between batteries to equalise battery life and to ensure that the very low battery drain is used to the greatest advantage.

The instrument is contained in a resin-sealed hardwood case, which has been specially treated against acids and other corrosives.

PYE for pH

DYNACAP pH METER CAT NO. 11087.



Chemists have long awaited a pH Meter of this calibre : the use of a dynamic capacitor in the input stage provides exceptional zero stability, linearity and accuracy. Full advantage of this circuit is taken by the provision of expanded scales. The absence of grid current eliminates errors normally encountered when using robust (high resistance) electrodes. Absence of grid current is also important when operating over a wide range of temperature.

Basic scaling of the meter gives two main ranges of 0—10 and 4—14pH units on a 5 inch scale. This can be expanded to give, in effect, a scale length of 35 inches, allowing excellent discrimination : a lower scale reads from 0—20pH units, each division being 0.02pH : the range switch will select sub-ranges of 0—2pH, 2—4pH, 4—6pH, etc.

In addition to full automatic temperature compensation, manual temperature compensation is incorporated Millivolt ranges 0—1000 mV; 400—1400 mV; expanded ranges of 200 mV throughout the full range of 0—1400 mV.

In all cases 1 mA output for full scale deflection is given i.e. 100 µA/pH on main ranges, 500 µA/pH on expanded ranges. Recorders, etc. to a total series resistance of 10 kilohms—(5 kilohms on expanded ranges) may be used.

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Canning centrifugal dryers really save time and money in drying small articles, after electroplating, barrel finishing and other operations.

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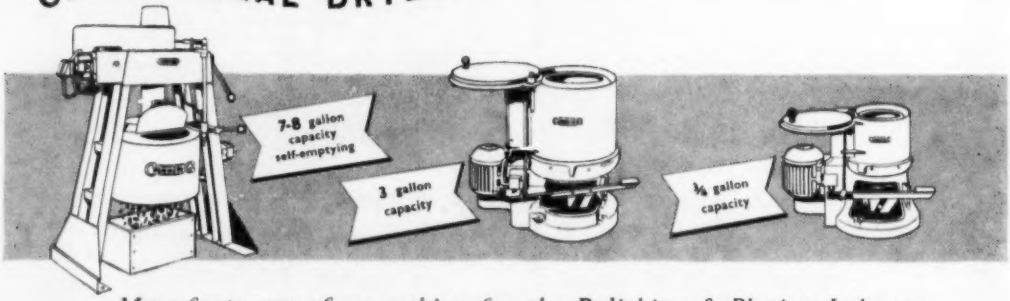

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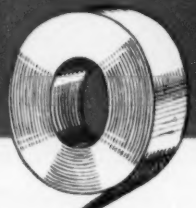

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How to get-

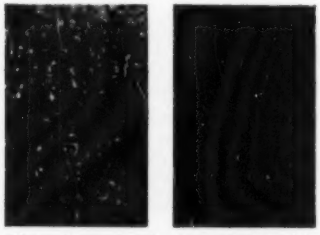
MORE CORROSION RESISTANCE

from --

CHROMIUM PLATE

Premature failure of decorative chromium finishes is nearly always the result of corrosion of the nickel, and other metals beneath it, starting at the base of the pores and cracks which are inevitable in all ordinary chromium deposits. Chromium itself is passive and does not corrode ; hence, by eliminating these pores and cracks, its corrosion protection is greatly improved.

Pores are eliminated by thicker plating. To overcome cracking, use the **UNICHROME BRIGHT CRACK-FREE CHROMIUM PROCESS** —the first process to yield deposits that are both bright enough for decorative applications and also free from corrosion-admitting cracks. It is already being used in motor car production with superior results.

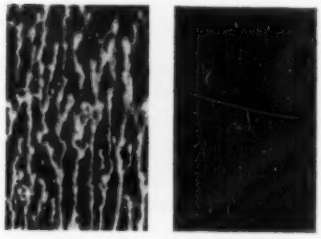


Chromium plated steel panels with 0.001" copper, 0.0005" nickel after 48-hours accelerated acetic acid salt spray. Left: ordinary chromium. Right: Bright Crack-Free Chromium.

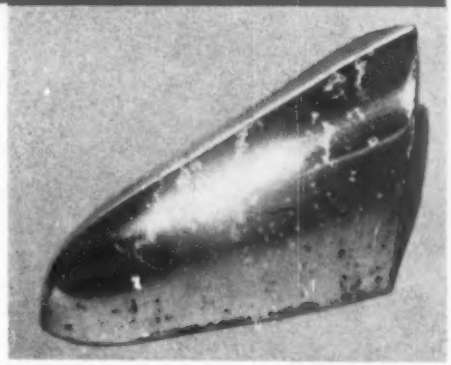
Other advantages include :

- ★ ***Self-regulation.***
- ★ ***Improved throwing power***
- ★ ***Better coverage, even over passive nickel***

UNICHROME



Chromium plated steel panels with 0.0005" copper, 0.0005" nickel after 220 hours regular salt spray. Left: ordinary chromium. Right: Bright Crack-Free Chromium.



Unichrome Bright Crack-Free Chromium made this difference in protection. Results of 72-hour acetic acid salt spray test on nickel-chromium plated car components. Above: Ordinary Chromium. Below : Bright Crack-Free Chromium.

For those who require thicker deposits, other UNICHROME processes offer the advantages of:

★ **Self-regulation.** ★ **Plating up to 80% faster than ordinary processes.**
★ **Less dulling or burning.** ★ **Less susceptibility to clouding due to current interruption.** ★ **Greater thicknesses without nodularity.**

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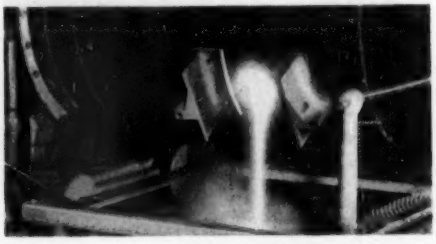

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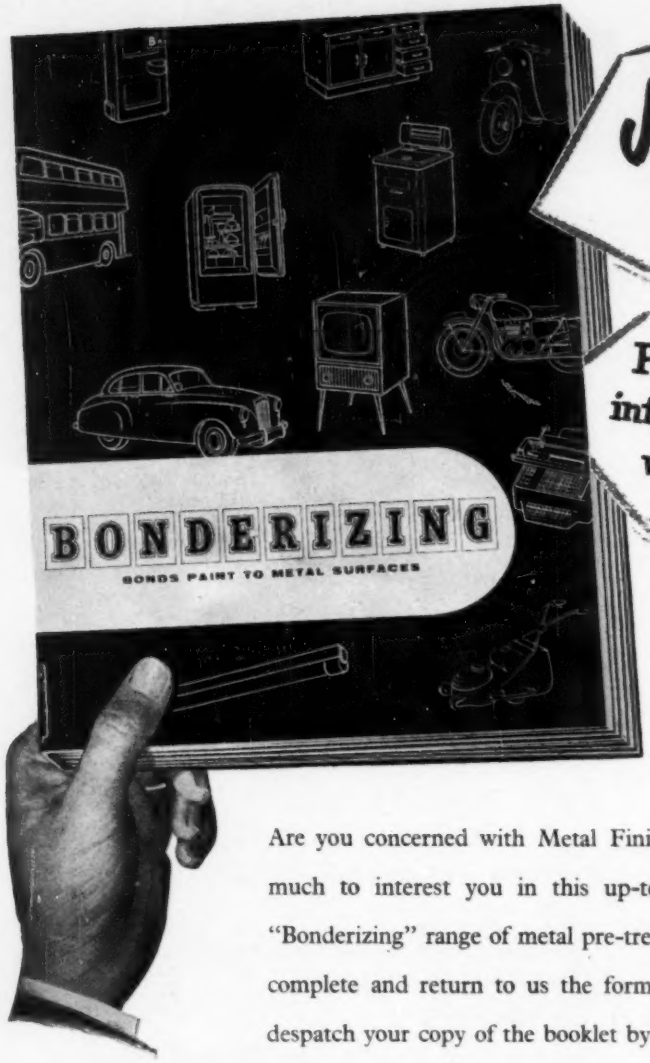
Contents

	PAGE
The Fleeting Year	3
Talking Points *"Platelayer"*	4
Diffusion Coatings for Metals *R. L. Samuel, Ing. Chim., A.I.M.*	5
The Painting of Machinery Components *B. van der Bruggen*	12
Purification of Chromic-Acid Solutions by means of Cation Exchangers *Gunnar Gabrielson*	19
New Car-Body Finishing Line for South Africa	22
Plating of Titanium and its Alloys *T. A. Dickinson*	24
Old-Established Roto-Finish Plant in operation at the Blackburn Works of British Northrop Ltd. *R. C. Liebman*	26
Finishing Post	28
Finishing News Review	29
Plant, Processes and Equipment	39



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THE FLEETING YEAR

THE ever accelerating rate at which time appears to pass must be a purely subjective phenomenon, and the speed with which 1958 *has come and gone must presumably be attributed to the onset of middle age. We are told by those older and presumably wiser than ourselves, that the tempo of the passage of time increases with each passing year, and if such is indeed the case by the end of the next decade the years will have shrunk to such proportions that they will scarcely be worthy subjects for an annual review.*

It has seemed that we have scarcely removed the Torquay Metal Finishing Conference dust from our shoes before we are eagerly awaiting details of the 1959 *conference in Brighton. And what a year for conferences* 1958 *proved to be—Metal Finishing at Torquay, Hot-dip Galvanizing at Knokke, and Vitreous Enamelling at Gleneagles, to say nothing of One-day Symposia, Platers' Nights, Forums (or should it be Fora) and Exhibitions. There has certainly been no letting-up on the metal-finishing technical front however much its commercial aspects may have wilted in the deflationary drought.*

In spite of difficulties in obtaining credit, and restrictions on capital expenditure, which characterized the earlier part of the year, a considerable number of new plant installations and extensions to existing facilities were brought into service during 1958 *and these can be taken as evidence of a well-founded optimism in the future prospects of the finishing industry.*

We have grown familiar in recent years with the growing keenness of competition between different materials, and to the ranks of the development Associations actively engaged in promoting the use of aluminium, zinc, copper and many other materials, can now be added the Vitreous Enamel Development Council formed by the suppliers of materials and equipment to the trade to foster and extend the uses and applications of vitreous enamel as a metal finish. 1959 *sees the Silver Jubilee of the Institute of Vitreous Enamellers, the body which has not only catered for the technical requirements of the enamelling industry, but which has also in default of the existence of a more suitably equipped organization borne in the past the burden of interpreting to the ultimate consumer the virtues of enamel as a finish. This is a task for which a technical institute on the British pattern is neither designed nor equipped, yet at the same time such an Institute can only operate effectively against the background of a successful and expanding industry. The Institute of Vitreous Enamellers can be expected to benefit from the shedding of a portion of its ill-assorted load and from the greater prosperity which should accrue to the enamelling industry as a result of the activities of the V.E.D.C.*

Another feature on the metal finishing front, which although of earlier origin than 1958 *did achieve its major manifestation during that year, has been the transmutation of the Institute of Metal Finishing from a Society of practioners in electroplating to a technical Institute dealing with phenomena of electrochemistry and surface reactions. This transmogrification has not been achieved without some heartburnings on the part of those whose needs were met by discussions at a less academic level, but the need for an authoritative technical body to stimulate a realistic attitude to the technical needs of the industry cannot be gainsaid. During the handful of weeks that will presumably go to make up* 1959 *there will be many opportunities to study the operation of the I.M.F. at its new level.*

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

MIXING THEM

SUCH a wide variety of alloy electrodeposits has already been explored that it is difficult to think of many new possibilities in this direction which have not been either rejected for one reason or another or already found practical use.

It is, therefore, interesting to see that one of the large American aircraft companies claims to be able to obtain quite outstanding corrosion resistance on steel with a cadmium-tin deposit containing 25 — 35 per cent of tin produced from a fluoborate bath. Coatings only .0001 in. thick withstood 1000 hours of salt spray before the basis metal showed rusting, whilst deposits .0003 in. thick showed no rust after 32 months exposure. Tin-zinc deposits have, of course, been known for some years and although they are good they do not give such remarkable results as these. This alloy is, however, normally plated from an alkaline solution and usually contains a much higher percentage of tin.

Cadmium-nickel deposits are also claimed to give a high degree of corrosion protection at elevated temperatures (up to 900°F). The nickel is plated first (.0002 — .0004 in.) and is followed by cadmium (.0001 — .0002 in.) The alloy coating is formed by diffusion, the composite coating being heated in air at 620 — 640°F. for at least 30 minutes.

MORE RECTIFIERS

SOME time ago there was a controversy in these columns as to the relative merits of motor-generators and rectifiers for the conversion of a.c. to d.c. for electroplating and similar processes. This arose from the fact that generators are still widely used in the U.S.A. whereas in Europe they are not even considered.

The use of rectifiers, and of germanium in particular, has been endorsed recently by the installation of what is probably the largest group of germanium rectifying units in Europe at the new brine electrolysis plant of the Associated Ethyl Co. at Ellesmere Port. Germanium was selected because of its high efficiency at low voltages. Each of the considerable number of electrolytic cells takes 30,000 amps. at about 4 volts, the cathode current density being some 300 amps. per sq. ft. It has been estimated that the power consumption of the plant is greater than that of the City of Chester.

INTRIGUING ABSTRACT

ABSTRACTS are useful not so much for the time they save or the information they impart, but as an indication to the reader as to whether the original paper is going to be of interest to him. Occasionally, however, an abstract can be so intriguing that the reader may be impelled by sheer curiosity to go to the original. A case in point occurs in "Metallurgical Abstracts" which condenses a paper by A. J. Marino very laconically as follows :—"The explosion caused by a 10 lb. block of Na placed on a frozen river blew a hole 10 ft. in diameter in the 4-6 in. thick ice".

Innumerable questions come to mind to which one would like an answer. Was the Na dropped into the river accidentally and if so what happened to the man who did it ? If the experiment was deliberate what was the object ? If it was to blow holes in ice, are there not simpler and cheaper ways of doing it, because who would want to carry 10 lb. blocks of sodium around for such a purpose ?

The whole thing seems altogether too esoteric, but no doubt the original paper is nothing like as exciting as the abstract !

ACID COMMENT

FROM instructions issued with their bathroom fittings by the Barking Brassware Co., Ltd. "Many modern cleaning materials contain mild abrasives and sometimes even nitric acid. Please do not use these as they will damage the chromium plating very quickly".

Perhaps there are polishes containing nitric acid, although I cannot say that I have ever met one. Surprisingly, the whole question of polishes for chromium has received little attention from platers or metallurgists, yet the metal is cleaned more or less often with polishes which can materially affect its durability one way or another.

Polishes are formulated so as to combine maximum cleaning action with minimum abrasion. What is really wanted, however, is a polish which will protect the deposit as well as clean it, and so reduce the need for frequent cleaning. It should not be impossible to develop such a polish, perhaps by the incorporation of some kind of corrosion inhibitor.

DIFFUSION COATINGS for METALS*

By
R. L. SAMUEL
Ing. Chim., A.I.M.†

Introduction

IT is hardly an exaggeration to say that for many engineering application a metal part is only as good as its skin. Whenever a component is subjected to wear, corrosion or heat, it is the surface that plays the important part, the core, the body of the thing, being there, literally, in a supporting role.

Technology has developed many skins for metals in the shape of a vast range of surface treatments. These treatments all have their own valuable characteristics and are adapted to the specific use for which the component has been designed.

Some protective coatings such as paints, lacquers, gilding, cladding etc. were known for thousands of years; tinning and galvanizing are long-established processes and electroplating is now an everyday word. Industry talks with assurance of phosphating and anodising, and timid claims on behalf of vacuum deposition, a technique not too well known to the world at large, are heard. In this paper the author proposes to consider in a simple manner the rather unique metal skins known as diffusion coatings.

If there is so much insistance on the word "skin" it is simply because it applies singularly well to diffusion coatings. In the same manner as the skin is a natural adjunct to the flesh and cannot be parted from it without serious difficulty, so it is with a coating which is an alloy of the protective metal and of the base material. Perhaps the word coating is not a happy choice, since the diffusion zone and the core form one integral whole where the structure and composition change gradually from the surface inwards.

Diffusion processes are not new in metallurgy. Many techniques of metal extraction and refining are based on diffusion effects, and so are carburizing, nitriding and oxidation of metals. A case-hardened part is not regarded as a coated article and no attempt would be made to strip off the coating.

However, the present subject is somewhat more limited and this account will deal mainly with metallic diffusion coatings (*i.e.* coatings of one metal into another metal) and will cover such processes as zinc diffusion (sherardizing), aluminium diffusion (calorizing), silicon diffusion, chromium diffusion, etc.

If the main emphasis is placed on the group of processes represented by chromium diffusion or chromizing, it is because this type of process has been studied more fundamentally than the earlier zinc and aluminium diffusion methods and also because it is more versatile in its present and potential applications.

Diffusion

In proceeding to give an account of diffusion coatings, it is convenient to start off by defining as simply as possible what is meant by the process of diffusion.

If, for instance, two miscible gases, A and B, are considered which are brought in contact at some stage, diffusion can be defined as the process which causes these gases to attain a uniform mixture composition throughout the system. Clearly, the condition of equilibrium will be reached and the diffusion will cease when the whole mixture has a uniform distribution of each component gas corresponding to the proportion of A and B at the time of mixing.

This phenomenon is, not limited to gases, but applies as well to liquids and to solids, or to combinations of states, such as gas/solid, gas/liquid or liquid/solid. While the diffusion process is fundamentally the same in all these cases, the extent to which it occurs and the rate at which it proceeds varies considerably. This paper is concerned with a limited aspect of this general problem, namely, the diffusion of elements into solids (metals, particularly) from the surface.

*This article is based on a lecture, which was one of a series on "Recent Developments in Metal Finishing" held at the Borough Polytechnic, London.

†Research Director, Metallic Surfaces Research Laboratories Ltd.

Surface Diffusion in Solids

The solid state is matter in its most compact form where molecules are close to each other, and, in the case of crystalline structures, the atoms or ions are arranged in accordance with well-defined geometric patterns. In this pattern, or crystal lattice, the distance between each individual atom (or ion) is very small and of the order of 2 to 4Å. Such a close-knit system is clearly not one which will permit easy permeation or penetration by other atoms and it is true to say that, in general, considerable thermo-chemical forces must be exerted in one form or another to achieve diffusion of most elements into metals by surface reaction.

Whatever the mechanism of diffusion, the energy required by the process is most conveniently provided by heat and this explains why most diffusion methods are, as a rule, carried out at comparatively high temperatures.

As for the way in which atoms of one element can diffuse into a compact metallic lattice, there are several possibilities :

(a) If the atoms calling for admission are very small, such minute intruders may infiltrate between the larger atoms in the lattice pattern without too much trouble and will find enough elbow-room for a fairly rapid penetration. This mode of infiltration is called interstitial diffusion. It is a very important type of diffusion mechanism, and a mixed blessing, since the interstitial diffusion of carbon in austenite makes it possible to carburize steel, a process of major significance, while, presumably as a measure of compensation, hydrogen can penetrate steel along the same channels and create this most dreaded scourge of the metallurgist, hydrogen embrittlement.

(b) When atoms of metals (chromium, for instance) face the solid barrier of a steel surface, there is little hope for these comparatively large visitors to force their way in *between* the equally large atoms of iron. Such inclusions could only be achieved by brute force, calling for a very large supply of energy, and would cause excessive distortion of the ordered lattice of the iron atoms.

In common with most insoluble problems, this one calls for a compromise — instead of the chromium atoms penetrating by *inclusion* within the system, advantage is taken of the structural defects of the iron lattice where there are many atoms out of position, creating " vacant sites." It is then possible for atoms to move from one interstitial position to another or for a vacant site to migrate, thus creating the diffusion effect. This mechanism, lattice diffusion, is most frequent when metals interdiffuse.

(c) When metals solidify from the liquid state, they usually form large agglomerates of crystals of similar orientation which are identified as " grains ". However closely these grains are bound to each other, their boundaries create discontinuities of structure with numerous gaps and these may prove convenient paths for diffusing atoms. Grain-boundary diffusion is fairly frequent in systems where a gas is in contact with a metal, such as in some types of oxidation mechanism.

As this paper is concerned with diffusion of one metal into another, emphasis will be placed on " lattice diffusion ".

Much has been written concerning the mathematical aspect of diffusion into solids, but it is necessary only to consider the simplified form of Fick's Law applicable to linear diffusion. This can be expressed $x^2 = 4kDt$ where the depth of diffusion x is related to the time t, k being a constant depending on the concentrations at the surface and at depth x and D the diffusion constant.

Having outlined the general aspects of diffusion into metals, it is now possible to select a suitable example and illustrate with it the chief factors controlling a diffusion process.

Surface Reaction and Diffusion

In the previous discussion, it has been assumed that the diffusing metal (solute) was present in suitable quantity and form at the surface of the diffused metal (solvent).

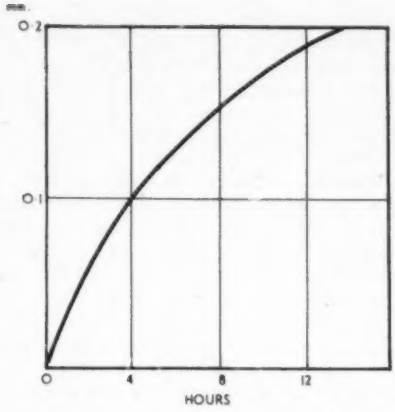
It should be clear, at this stage, that while the diffusion mechanism is purely a physical effect depending on the concentration of solute at the surface, on time and on temperature, there are many ways by which diffusion coatings can be obtained, according to the method chosen for applying the solute metal on the surface of the solvent.

A process for coating by diffusion will consist of two distinct steps which can be entirely separate or, achieved simultaneously, namely:—1. Surface Reaction (deposition). 2. Diffusion.

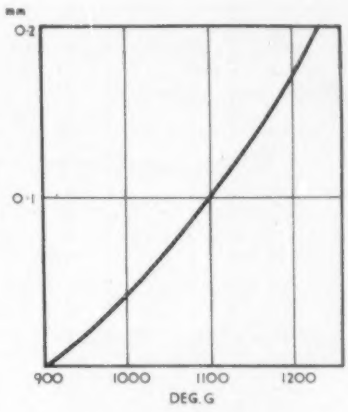
To quote a simple instance, if it is required to obtain a diffusion coating of zinc on a steel article zinc may be applied on to the steel surface by any one of a variety of processes such as : electroplating ; zinc-spraying ; vacuum-deposition ; hot-dip galvanizing etc. In each case a coating of zinc will be obtained, but no diffusion (with the exception of a thin diffused transition zone in the hot-dip galvanized part).

By heating these parts at suitable temperature in non-oxidizing atmosphere, zinc will diffuse into the steel parts and will form an alloy coating, roughly identical in each case. On the other hand, it may be more convenient to combine surface reaction with diffusion and the part may be heated in contact with zinc powder and a diluent at a temperature of around 450°C., in which case a similar diffusion coating will be obtained in one operation.

Little need be said about methods of deposition



Figs. 1 and 2 Chromizing on low-carbon steel. Fig. 1 (left) Coating thickness at 1100°C. Fig. 2 (right) Coating thickness: 4 hours' treatment.



other than simultaneous deposition and diffusion, since these methods are established processes in their own right and have been discussed at length elsewhere.

Probably the most interesting and certainly the most widely used method of deposition and diffusion is based on the reaction of a halide of the diffusing metal on the solvent metal at elevated temperature. Chromizing is a typical example of this method and will provide a convenient starting point for illustrating this type of process.

Chromizing

Briefly, the process consists in heating a metal part (steel for instance) at a temperature of from 900 to 1100°C. in the presence of a gaseous halide of chromium. Generally, a reducing atmosphere (hydrogen, cracked ammonia) is used at the same time.

In the case of chromizing of iron or steel, the following reactions (where x represents fluorine, chlorine, bromine or iodine) can take place :—

i. Interchange $Fe + CrX_2 = FeX_2 +$ Cr.

ii. Reduction $CrX_2 + H_2 = 2\ HX +$ Cr.

iii. Thermal dissociation $CrX_2 = X_2 + Cr.$

In the interchange reaction, one atom of iron is removed for each atom of chromium deposited. Since iron and chromium have similar atomic weight and volume, the reaction takes place without significant change of weight or dimension of the iron article. Both the reduction reaction and thermal dissociation cause an increase in weight and a slight dimensional change since no equivalent amount of iron is removed.

The thermodynamics of interchange and reduction reactions have been the subject of many investigations and a good deal is known about the conditions controlling their nature and efficiency. A discussion of this topic is outside the scope of this paper, but it may be stated that consideration of the free energy of formation of halides and hydrogen halides allows a convenient method for predicting the possibility of interchange or reduction reactions occurring at given temperatures.

Whatever reaction is used in depositing chromium on the surface of steel, the diffusion proceeds at a rate given by $x^2 = 4kDt$ and since it has been established that, in the case of chromising, k is approximately equal to one, the equation becomes $x^2 = 4Dt$.

The values of the diffusion constant D are only approximate but the following figures, relating to the diffusion of chromium in a low carbon (0.1 per cent.) steel, will serve as a guide :

Temperature °C.	*Diffusion Constant D. cm.² sec.⁻¹*
970	1.6×10^{-10}
1000	3.0×10^{-10}
1050	7.0×10^{-10}
1100	15.0×10^{-10}

In practice, steel is chromized at temperatures ranging from 900°C. to 1100°C.

At 1000°C., a treatment of 5 hours will give a coating thickness of approximately 0.05 mm. (0.002in.).

The relation between time, temperature and coating thickness is shown in Figs. 1 and 2, and, as could be predicted from the simplified form of Fick's Law, the curve in Fig. 2 is a parabola.

The structure of the chromized coating can be explained by considering the iron-chromium constitution diagram in Fig. 3. The sharp boundary, corresponding to a concentration of chromium of approximately 12 per cent., is due to a change from γ to α structure at the temperature of processing; the difference between rates of diffusion in α and γ iron also accounts for the sharp drop in chromium concentration at the boundary shown in Fig. 4.

When a section of chromized iron (or steel) is

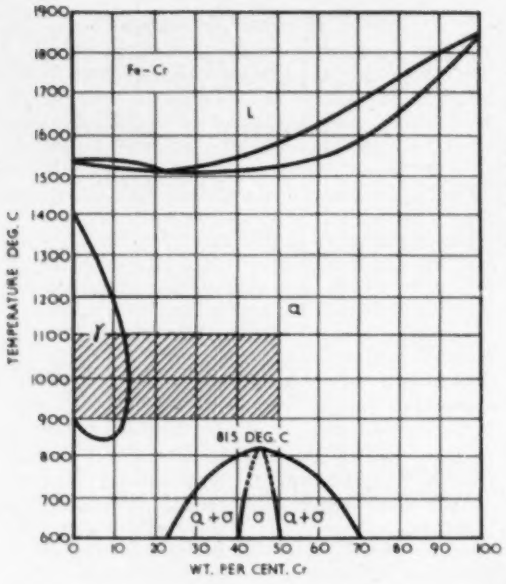


Fig. 3.—(above) Iron-carbon diagram

Fig. 4. (right)— Chromium concentration as function of distance from surface in m m.

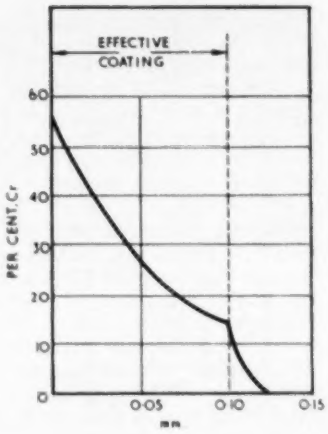
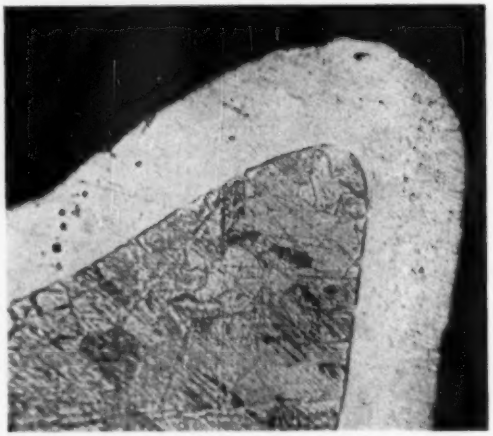


Fig. 5.—(below) X 100. Chromized screw thread. Nital etch.



etched in nitric acid, the outer layer of chromium content higher than 12 per cent. remains unetched while the iron core develops its normal gain structure. The unetched part shown in Fig. 5 is termed the coating. It must be remembered, however, that chromium has diffused further than is shown by the etched boundary, but if the sectioned test-piece is immersed in hot dilute nitric acid, only the steel core is dissolved leaving intact, as a continuous shell, the chromium-rich coating.

Structure and Physical Properties of Chromized Coatings

Since the surface alloy is made up from chromium and the parent metal (iron or alloy of iron) it follows that the diffusion layer will have structure and properties which can vary widely according to the chemical composition and to the physical structure of the material to which it is applied.

Previous discussion has assumed that the process was carried out on pure iron or very low-carbon steel ; pure iron is seldom used in practice and low-carbon steel is only one of many steel specifications in current use in industry.

The carbon content of the steel has a profound influence on the structure and properties of the coating. Chromium has a greater affinity than iron for carbon and, as a result, any carbon in the steel tends to migrate towards the surface and combine with chromium, thus slowing down the diffusion of chromium inwards.

It is possible to prevent this retarding effect by including in the steel sufficient amounts of strong carbide-forming metals such as titanium, vanadium, molybdenum etc. . . which fix the carbon in the form of stable carbides, thus allowing chromium to diffuse in a pure iron matrix.

Other alloying elements in steel can be classified according to their effect in favouring a ferritic or an austenitic structure. Manganese, nickel and cobalt are austenite formers (a structure slowing down chromium diffusion); chromized coatings are therefore shallow and of high concentration. Conversely, chromium, silicon, aluminium and, to

some extent, vanadium, molybdenum and tungsten are ferrite formers. They favour the formation of deeper coatings with relatively lower chromium content. Sulphur and phosphorus must be kept to the lowest possible concentrations since they interfere with the surface reaction and also with the diffusion mechanism.

The hardness of chromized coatings can vary from 200 V.P.N. for iron or low-carbon steels to 1500 to 1800 V.P.N. on high-carbon steels (over 0.7 per cent.) and cast-iron. The reason is that the coating in the first instance is a simple ferritic chromium iron, while with high-carbon steels, there is a considerable amount of chromium carbide present.

Coatings obtained on low-carbon steel have good ductility and can be subjected to mechanical deformation such as rolling, bending, pressing etc. It is therefore possible to chromize blanks in sheet steel and to press or form to shape as a subsequent operation.

It should be borne in mind that the temperature of the chromizing treatment results in a full annealing of the steel core and when high tensile strength is required in the finished article, a subsequent heat-treatment is necessary.

Provided reasonable care is taken, all normal methods of welding can be applied to chromized steel. Preferably, austenitic stainless steel welding rods are used with arc or gas welding; spot and resistance welding can also be used. In common with all coated materials, it is important to avoid excessive overheating which might damage the protective coating.

The combination of good ductility and weldability makes chromized steel a suitable material for fabricating from flat blanks and it is often when used in this manner that the process proves most economical.

Corrosion and Oxidation-resisting Properties

The chromized coating of a low-carbon steel is essentially a high-chromium ferritic iron of average 22 to 25 per cent. chromium. The surface concentration of chromium is higher and of the order of 50 per cent. so that the behaviour of such coatings, particularly to dry corrosion, is usually better than an average chromium stainless iron.

The following table gives an approximate picture of the properties of a chromized low carbon steel:—

Corrosion Agent.	*Ranking*
Atmosphere — dry	Excellent
Atmosphere — wet	Good
Tap Water	Good
Alkali and soap water	Excellent
Salt (sea) water	Medium
Fruit juices	Good
Milk products	Excellent
Oils — petroleum	Excellent
Dilute nitric acid	Good
Bleaching solutions	Poor
Dilute hydrochloric acid	Poor
Dilute sulphuric acid	Poor
Steam at high temperature	Good
Oxidation up to 950°C.	Excellent
Combustion gases (up to 950°C.)	Excellent
Sulphur-rich gases (up to 950°C.)	Good
Molten cyanide bath	Good
Molten chlorides bath	Poor
Molten nitrite (nitrate) bath	Poor

The selection of a special steel, such as titanium-stabilized low-carbon steel improves considerably the resistance to wet corrosion.

The oxidation properties of chromized steel at high temperature are particularly good, even when sulphur-bearing gases are present and the extremely small rate of oxide formation for prolonged periods at different temperatures is shown in Table I.

Table I

	Weight increase in mg/cm.²	
Temperature °C.	After 100 hours.	After 200 hours.
700	0.015	0.020
800	0.60	0.85
900	1.40	2.80
950	2.10	6.10
1000	4.30	11.20

It is noticeable that, at temperatures above 900°C., the rate of oxidation increases very sharply. This is due to the fact that the temperature becomes sufficiently high to promote further diffusion of chromium with a resulting drop in concentration at the surface and consequently lower resistance.

Normal chromized steel should not, therefore, be used for prolonged periods at temperatures over 900°C., but additions of aluminium and/or silicon to the coating can raise the effective range of temperature of use to 1000°C. and higher.

Applications of Diffusion Coatings

The industrial applications of diffusion processes and a brief review of their modes of operation are now considered.

(a) *Zinc-diffusion (Sherardizing)*

Zinc-diffusion was first introduced as a commercial process some thirty years ago. The process is very simple and requires only a rotary drum retort operating at a temperature of 400 to 500°C. The parts to be treated are mixed with a compound containing zinc dust and an inert

refractory filler and are rotated for a few hours at temperature.

The zinc-iron alloy coating has a matt-grey appearance and shows adequate resistance to corrosive agents, particularly atmospheric corrosion and industrial atmospheres. Its applications include screws, bolts, nuts, washers and threaded parts in general, which take advantage of the very small dimensional change caused by the process; the process can also be used for other components exposed to atmospheric corrosion, such as electrical conduit, tubes, chains, switchgear parts, railway signal parts, steel scaffold fittings, iron railings, hinges, handles door knobs and knockers etc.

Sherardizing is essentially a specialized method galvanizing more particularly suitable for mild corrosive conditions.

(b) *Aluminium Diffusion* (*Calorising*).

Aluminium diffusion can be obtained on iron or steel articles by heating the parts in contact with a compound containing powder aluminium, a refractory filler and a small portion of ammonium chloride in a rotary retort.

A treatment of 4 to 6 hours at 850 to 900°C. produces a coating of 0.002 in. to 0.005 in. containing about 60 per cent. aluminium. This coating is comparatively brittle and the normal practice consists in re-heating the parts in a separate furnace for 12 to 48 hours at 900 to 950°C. to allow further diffusion to take place. The aluminium content is then reduced to 25 per cent. and the coating is less brittle. It is possible to combine the two treatments in one single operation by using gas-tight static retorts and careful control of the aluminium content of the active mix.

The major value of aluminium diffusion is its resistance to thermal oxidation and to thermal corrosion in presence of sulphur-bearing gases. It is not used for corrosion prevention.

The re-diffusion effect mentioned earlier for chromizing occurs at lower temperature with aluminium diffusion so that only comparatively thick sections ($\frac{1}{8}$ in. or more) can be used for prolonged periods at temperatures over 900°C.

Fabrication of calorized part is difficult since the coating is not really ductile and, as a rule, only finished articles can be processed. These include :

Heat-treatment pots for salt, cyanide and lead ;

Bolts for high-temperature use ;

Tubes for air-heaters, superheaters, gas polymerizers ;

Furnace parts and jigs used at temperatures up to 800°C. etc.

(c) *Chromium Diffusion* (*Chromizing*)

Chromizing has only been developed commercially during the last fifteen years. All the different processes in use to-day are based on the reaction of a chromium halide on the steel surface but they can be divided into three groups, according to their mode of operation.

1. Gas-phase processes	(Articles out of contact of solid active reagents)
2. Semi-gaseous processes	(Articles in contact with granular reagent in a retort, atmosphere circulated during processing).
3. Pack processes	(Articles packed in sealed boxes or retorts in contact with solid reagents in powder form).

There are minor differences in the results obtained by these various processes since each has its own characteristic advantages and shortcomings, but, on the whole, the selection of the process depends essentially on its suitability from a cost angle for any given application.

Thus, pack processes lend themselves admirably for the treatment of flat articles, strips, sheets, plates etc. . . which can be subsequently fabricated, since close packing can be achieved with only a fraction of an inch space between each plate.

Chromizing can be applied as a protection against corrosion, heat and wear.

Corrosion-resistance. As a rule, a good standard of resistance to corrosion is obtained on steels of low carbon content (0.1 per cent) ; if, however, the parts are to be subjected to severe wet corrosion and, particularly, to salt-water corrosion, it is advisable to use a titanium-stabilized low-carbon steel which promotes the formation of thick, pore-free coatings.

Among applications within this group, are : bolts, nuts, screws, washers, threaded parts in general for use in the food industry, oil and petroleum, paints and plastics, chemical engineering etc. Articles of complicated shapes can be processed since the gas reaction provides complete coverage of the surface, even at the root of fine threads. Thus, parts for water, and oil pumps, shafts, gears, c[illegible] be successfully treated. Small parts, such as s[illegible]ws, rivets etc. or link chains can be processed by rotary furnace technique.

There are also many applications for household and domestic appliances — kitchen utensils, washing machine parts, hinges, locks etc.

Heat-resistance. There are many applications in this field. The ease of fabrication of chromized steel sheets and the reduced cost of material as compared to heat-resisting alloy steels has found outlets for the process in the industries concerned with industrial and domestic gas appliances, paraffin and oil burners, electric heaters etc.

Examples of components which are treated as flat " blanks " and fabricated after chromizing include grill-frets for gas cookers, burner sleeves, baffles, rods etc. for paraffin burners, panels for infra-red drying ovens, parts of motor car silencers etc. Among other applications, are burner nozzles for gas or oil furnaces, gas pokers, brackets and tubes for super-heaters and heat exchangers, heat-treatment jigs and fixtures, pyrometer stems etc.

Chromizing can also be used for improving the oxidation and thermal corrosion resistance of high-temperature alloys which are prone to develop intercrystalline oxidation. Such applications are found in parts such as turbine blades, flame tubes, tail cones etc. for gas turbines and jet engines.

It should also be mentioned that a chromized surface markedly improves the adherence and thermal shock resistance of vitreous enamels, ceramic and refractory oxide coatings.

Wear-resistance. It has been mentioned earlier that when chromium is diffused into high-carbon steels, the complex coating is extremely hard (1500-2000 V.P.N.) and contains a large proportion of chromium carbide.

Such coatings find ready applications in several fields such as : fibre and thread guides, parts for textile machinery (nylon, cotton, artificial silk, etc.) ; saws, files, taps, dies, drills etc. for use on plastics and metals where abrasion is considerable ; forming and cupping tools for aluminium, steel, titanium etc. ; dies and moulds for the glass industry which are subjected to a combination of wear and thermal shock.

Other Processes

In addition to the three main processes available in this country siliconizing has been in commercial use in America for several years. The silicon-iron coating (average 14 per cent. silicon) is somewhat brittle but has good resistance to nitric, hydrochloric and sulphuric acid, is a useful protection against oxidation and has a low friction coefficient.

The process has been used with success for the treatment of water-pump shafts, large cylinder liners and valve guides, steam and water valves, and tubing for heat-exchangers and superheaters.

Conclusion

The technology of diffusion coatings is only in its early stage. The ever-changing requirements of modern engineering in the fields of gas and jet turbines, and nuclear energy have stressed the need for a wider range of diffusion coatings and research is proceeding at a rapidly increasing pace to meet these new demands.

It is now being realized that few materials on their own can adequately combine strength in the mass and chemical stability at the surface. One answer is to select a material which possesses the most suitable physical properties and to protect its surface with a continuous, unstrippable coating.

This outlook calls for close co-operation between the user, the designer, and the surface technologist ; under such conditions a technically sound and competitive article can usually be produced. It is, therefore, well that each should know of the others problems and this brief survey will have served its purpose if it has made clear the uses and limitations of diffusion coatings.

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(*Continued in page* 28)

THE PAINTING OF MACHINERY COMPONENTS

Improved quality and faster production achieved by adopting modern techniques*

by B. van der BRUGGEN

MACHINERY components usually have a more or less coarse-grained, as-cast surface. Painting accordingly involves the application of a number of coats and if further complicated by the great difference in weight and shape of the parts to be treated (which frequently have already been subjected to mechanical surface treatment in places) by the long drying times required in most cases, as well as a multiplicity of intermediate operations and the resulting transporting and handling problems.

The following contribution shows that in spite of these factors, which in themselves increase the difficulties in regard to the rational application of paint coatings in mechanical engineering, there are many ways in which the finishing process can be speeded up and quality improved, even for varying and restricted series of parts.

Quality and Appearance of the Paint Coating

The high demands made today on the quality and colour-fastness of machinery paint work require not only the use of good paints but also thorough drying of each coating applied, as well as a technique ensuring easy application of the paint coatings.

Where it is not the practice to dry paint coatings—including primers—at elevated temperatures, then the room-temperature drying times usually assigned are not as a rule sufficient to allow the solvent and thinners in each coat to volatilize completely. In addition, the normally long drying times necessary for the air-drying pigments generally used—at room temperatures of 18 to 24°C.—in themselves make heavy demands on the economy of the working cycle (waiting time for drying each coating, preparation time).

The subsequent treatment of such hand-dry coatings dried at room temperature has shown, as a matter of experience, that paint structures which are at first sight entirely satisfactory in covering power and gloss, after a few months, *i.e.* after the expulsion of the residual solvent always remaining in each coating, shrink and visibly deteriorate. Not infrequently, small surface irregularities and hair cracks become clearly perceptible.

Paint Material—Number of Coats

Where it is not possible to speed up the drying process by raising the temperature, for instance, in a drying room equipped with rack trucks (an uneconomical cumbersome arrangement) the usual low room temperature of the particular location often necessitates the use of quick-drying, but in this case, less economical, paint materials. That is always a disadvantage, since although when applying paint, the stress to which it is to be subjected when the machinery is in use must be borne in mind, the selection of paints with the greatest possible coating power is essential today, particu-

*The original Swiss article on which this contribution is based was published in Industrie-Lackier-Betrieb, 26, pp. 67-72 (March 1958).

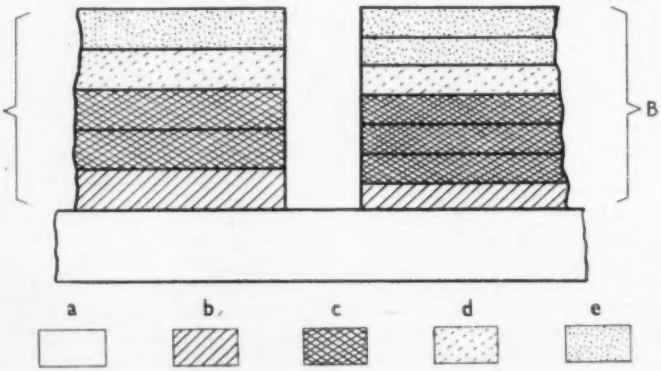


Fig. 1.—Diagram showing the number of coats in a paint application on a grey cast surface.

A. Material with oil-plastic base (5 coats).

B. Material with cellulose base (7 coats).

a. Metal surface; b. Primer; c. Filler; d. Undercoat; e. Topcoat.

larly when working on rough, as-cast surfaces. Paint consumption not only increases with the number of coats required, but also with the labour expended on applying these coats and also on any subsequent treatment which may be necessary (*e.g.* rubbing down).

Fig. 1 is a comparative diagram showing the number of coats applied on a cast-iron surface when using pigments with a plastic and a cellulose vehicle respectively. Where, as in the example selected, a regular coating structure is being dealt with, then, as a rule, the 4 to 5 coats of the material with an oil-plastic vehicle with considerably superior coating power which requires a correspondingly longer drying period, is to be preferred to the 6 to 7 coats required with paints on a cellulose or combined cellulose-plastic base.

Very frequently, considerable disadvantages are involved where the selection of the type of material and the coating structure must be dictated by or determined in the light of inadequate drying facilities or the lack of equipment and stacking space or by external conditions. Occasionally it is simply not possible to bear in mind the type of paint and the painting technique most suitable and most economical for a particular purpose.

Method of Application—Spraying

The total times required for paint application depend on the number of coats applied as well as on the number of parts to be treated. These times can be appreciable even where, *e.g.* only two coats are required for each painting operation (textile machinery). This is particularly true in regard to the time-consuming application of paint by brushing which can only be justified to some extent, in cases where it is a question of small parts, partly machined (*e.g.* drilled holes) or of badly cleaned surfaces (undercoats) or of stopping the surface of specially-shaped pieces, having regard to the slightly improved adhesion which can be obtained thereby. A coat applied with a brush can rarely compete in appearance with a sprayed surface, even in the case of a top coat on surfaces of moderate size. Painting with a brush is too frequently used in practice even for single pieces, particularly in cases where, as can be understood, it is desired to avoid the transporting and handling of the parts required when spraying is performed at fixed points (*e.g.* spray booths with rotating turntables) or where no suitable plant is available for spray painting.

Apart from the exceptions for instance, the need for extensive covered storage for painted goods, in most cases, lack of suitable equipment is the factor compelling the retention of brush painting, even for the treatment of easily transportable parts. If it is desired to make full use of the saving in time which can always be achieved by spraying, the sprayer must be relieved of all the labour of intermediate handling. Table I compares the saving in spraying times which can be achieved.

Table I. *Manual Spray Painting—Static and in Continuous Flow.*

Material treated: machine lever of grey cast iron Work sequence for single part	Time required	
	On turn-table* seconds	On conveyor seconds
1. Cleaning	—	—
2. Undercoat (sprayed)	50	30
0. Drying	—	—
3. Stopping (sprayed)	80	55
0. Drying	—	—
4. Rubbing down	—	—
5. First coat (sprayed)	60	35
0. Drying	—	—
6. Rubbing down	—	—
7. Top coat (sprayed)	70	45
0. Drying	—	—
Total spraying time	260	165

* Includes handling (taking up, reversing and setting down the part, also pistol handling times) as required with "fixed" spraying

Accelerated Paint Drying

The power cost for drying at a higher temperature then usually obtains in the shops is as a rule more than repaid. The advantages to be obtained by accelerated drying are several :

1. Unrestricted utilisation of materials with good covering properties—saving in material (higher solid content per kg. of paint).
2. Fewer coats of material per surface (labour saving).
3. Shorter drying time for each coating—shorter finishing time (more rapid freeing of floor space and plant).
4. Reduced waiting times and interruptions (*e.g.* rubbing down incompletely dried coats)—satisfactory utilisation of working time.
5. No subsequent falling of the coats—paint retains a good appearance for a long time.
6. Partial removal of solvents by extracting plant—improved atmosphere (respiratory hygiene).
7. Improved hardness and dust-free drying of the painting—improved quality.

Table II. *Paint Drying at Room Temperature and at Higher Temperatures—Oil-plastic-base Paints.*

Material treated: casing door of grey cast iron Work sequence for single piece	Drying time at	
	18-22° C. hr.	50-70° C. hr.
1. Cleaning	—	—
2. Undercoat	—	—
0. Drying	8-10	1.5-2.5
3. Priming (knife)	—	—
0. Drying	5-6	1-2
3a. Priming (pistol)	—	—
0. Drying	3-4	1-1.5
4. Rubbing down	—	—
5. First coat	—	—
0. Drying	7-9	1.5-2.5
6. Rubbing down	—	—
7. Top coat	—	—
0. Drying	10-12	2-3
Total drying time	33-41	7-11.5

Fig. 2.—Conveyor section.

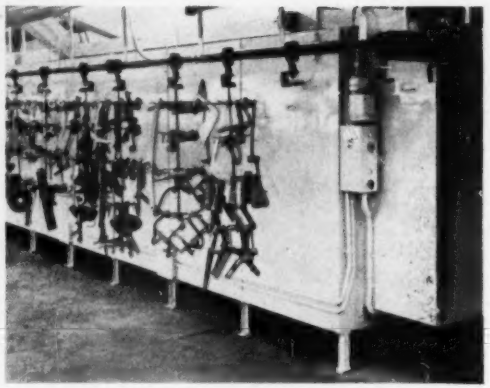


Fig. 3.—Tunnel furnace for drying small parts.

The suitable temperature level in the installations for accelerated drying of the normal air-drying paints is determined by their nature and composition. Experience has shown that savings in time of from 60 to 80 per cent compared with drying at room temperature, can be obtained, a combination of radiated and convected heat being required to attain the optimum, particularly where different kinds of paint are applied. Just as drying without radiated heat can be too slow, on the other hand, drying different air-drying paints without sufficient ventilation can also be insufficiently rapid, since in this case there are limits to the temperature which can be used. The above example of a practical case (Table II) gives some data and comparative figures, the applicability of which is restricted to the paints used on this occasion.

Transportation and Handling of the Parts

Disregarding parts of intermediate size, in mechanical engineering practice generally, three size groups of work to be treated need to be considered:

(a) Small, easily handled parts such as *e.g.* levers which often have a number of machined areas.

(b) Heavier parts of medium size, *e.g.* levers, casing doors, housings, etc., which can still be conveniently handled.

(c) Large, heavy parts, *e.g.* bed plates, baths, pedestals, which can only be moved with a trolley or lifting tackle.

An automatic, mechanized production flow is possible with groups (a) and (b). In most cases, group (c) only allows of an intermittent flow line, by arranging the processing shops or bays, *e.g.* for priming, rubbing down, spraying, drying, in the sequence of this work cycle. If these parts are very heavy, or awkwardly shaped, the choice is not infrequently presented between leaving them in one fixed location from the start or incurring considerable transportation costs and also loss of time. In the present article, it is not proposed to go any further into the treatment of group (c) although with these parts also the decision as to whether they are to be treated at a fixed location or can be conveyed to the processing plant at a reasonable cost depends largely on the types of equipment available (entry and passage facilities, etc.) and the transportation arrangements.

Parts coming under groups (a) and (b)—in comparison with which the number contained in group (c) is limited—require, on the contrary, that, as far as possible, manual transport shall be eliminated since only by this means can the manpower be best utilized for the specific, purely manual work such as surface cleaning (and, if necessary, derusting), priming rubbing down, painting, covering, etc.

As is clear from the foregoing, quick drying as well as spraying and in some cases flow-coating or dipping, offer appreciable advantages in the painting operations in mechanical engineering as compared with brush painting, static drying, etc. In order to make full use of these advantages, in regard to quality, appearance and finishing time, the flow of the parts through the plant for the purpose of spraying and drying must be rationally organized; otherwise, the benefits to be derived are considerably reduced, as is usually the case where flow production is not adopted.

Parts which in view of their size and weight can easily be moved on mechanical conveyors or can be arranged on these, should not require handling by the spray operator himself. Equally such parts should not need to be transported between the painting shop and the drying bay by trucks which are often loaded and unloaded only once for each paint coat. Medium-sized and small parts should be fed on a conveyor in the prepared state (free from dust) ready for spraying, to the appointed spraying shop. This conveyor (chain, belt, etc.)

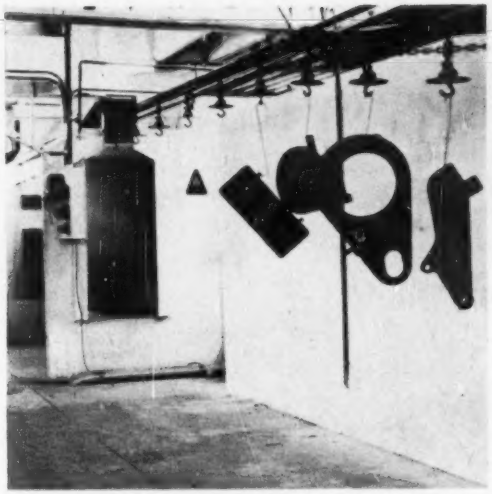


Fig. 4.—Side view of spraying booth for parts of medium size.

Fig. 5.—Spraying cubicle: passage opening with switch control panel.

is also used for transporting the parts for drying the paint coat, thus avoiding handling while the paint is wet (liability to damage, dust contamination). If such parts also require priming, rubbing down or brushing, then this should be considered in connexion with the conveyor and drying equipment, since otherwise a bottle-neck may develop at these points, due to excessively long drying times or increased handling, or differences in the appearance of the coat may result.

A Typical Installation

To supplement the above information, Figs. 2 to 15 show a modern plant for the painting of machinery components. The photographs have been obtained from a Swiss industrial organization who granted permission for the plant to be photographed.

It should be mentioned, in regard to the arrangement of the new, mechanized equipment that, prior to the introduction of accelerated drying,

Fig. 6.—Parts of different size on the conveyor passing on their way to paint application.

Fig. 7.—Medium-sized parts seen leaving the stoving oven.

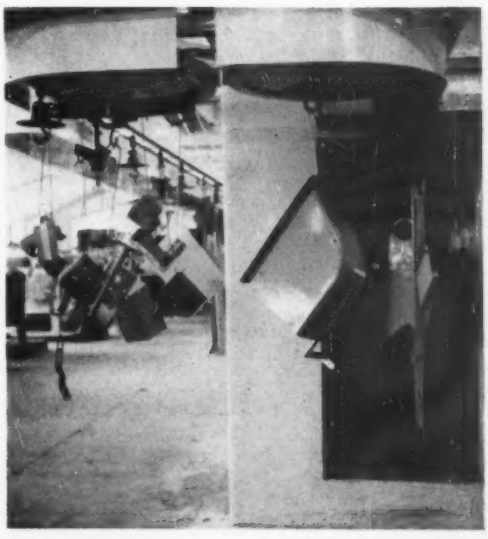


Fig. 8.—Tunnel stove with overhead conveyor.

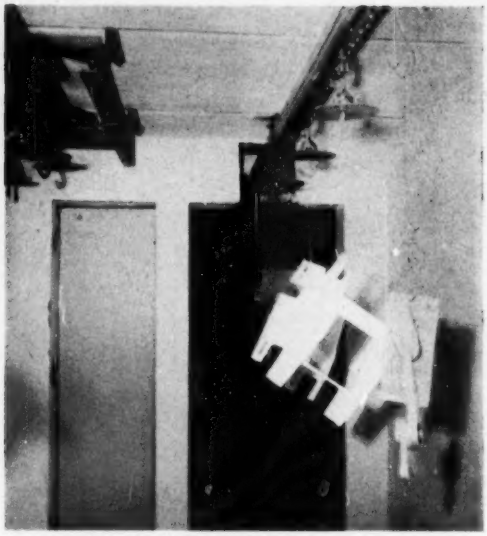


Fig. 9.—Painted parts in drying stove.

high-quality painting with first-class covering materials on an oil and plastic base was performed in this painting works and spray painting had been used for a long time. It had been necessary, however, to allow for correspondingly long drying periods.

In planning and designing the installation, one of the most important requirements was that the painted and dried parts should show no differences in shade or gloss on the assembly line following the painting. Since for certain reasons, the heavy, medium and small parts are treated and dried in different, separate installations, this called for particular care in designing the accelerated drying cycle, since some types of paint and bright colour tones react rapidly to increases or differences in temperature.

Thus, the possible danger of burning the painted coat, at least in the case of the small parts, did not arise and in planning the work cycle and selecting the type of equipment, it was necessary from the start — as with the painting of other machinery parts — to take into account that full-scale flow production as adopted in the painting of sheet-metal parts, was not possible, and in some cases was not even desirable. With the painting of cast components, owing to the dimensions of the pieces, and the heat absorbed, and bearing in mind the length of the furnace feeding zones, the drying times which can be obtained by raising the temperature do not allow continuous travel of the conveyor belts with all paint materials and with all weights of articles. This is true even where reductions up to 80 per cent are obtained, compared with the former drying times, at room temperature, as was the case in this plant.

Plants in which flow production (accelerated drying) and manual labour in some cases go hand in hand require to be planned in such a way that in the different sequences of operations which constitute multicoat painting, transportation between the areas served by the conveyors and the static workshops located elsewhere is kept to a minimum. This could in some cases be achieved by transferring some manual operations to the continuous flow areas.

The transportation of large, heavy parts, such as bed plates, etc., in this works is by truck, after spraying in a spray-booth. It was not considered necessary to mechanize the transport of this limited number of parts.

Fig. 2 shows the conveyor area in the painting section which, lighted from above, is also used for servicing the conveyor chains and for the inspection of sprayed parts. When greater numbers of components require to be treated, the small parts which can be seen in the foreground are arranged in batches.

Fig. 3 shows the tunnel furnace with mechanical feed for drying paint on the smaller components. The articles to be treated and dried are suspended from the conveyor, to economize on the limited floor space. During the drying times inside the tunnels, parts must be available outside the tunnel for manual processing. The rate of feed of the conveyor is, however, adjustable.

Fig. 4 gives a view of the paint-spraying bay. The primed cast components which can be seen

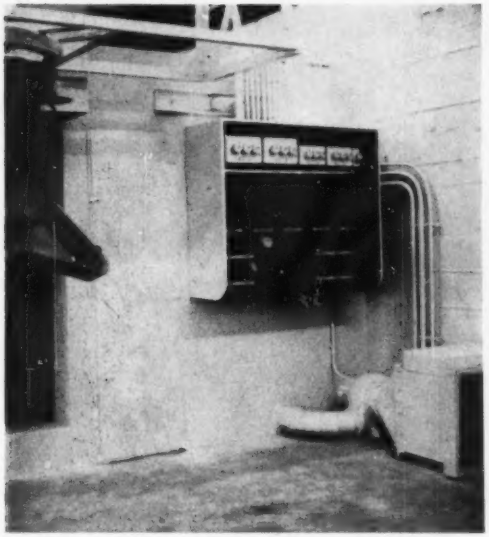


Fig. 10.—*Switch control panel for stove heating and ventilation.*

Fig. 11.—*Tunnel passage with rising conveyor section.*

on the chain are of the most varied shapes so that only a manual spraying process is feasible for these parts. Holes and pocket-shaped recesses would retain too much paint if a dipping or flow coating process were adopted. Electrostatic paint application is not practicable owing to the wide range of goods to be treated, apart from other considerations. Above all, it would not be possible to ensure the necessary flexibility in the plant which is indispensable with the frequent changes in the feeding rate of the conveyors and the manual operations on the chain.

Fig. 5 shows the switch-gear for the motors of the fans, compressed-air washers, feeding equipment, etc. It is sited to be within reach of the sprayer and is arranged for stepwise control. The construction of the drying installation and the lengths of the feed tracks for each working process or operation permit interruptions of the feeding process.

Fig. 6 shows the water screen of the paint mist washing section. The painted parts travelling along in the foreground have the most complicated shapes, similar to those of some of the sprayed articles. With these goods of medium size, simple suspension from a single hook is possible in many cases.

Fig. 7 shows the high-intensity illumination for the sprayed articles. This is arranged above and behind the spray operator (*see* also Fig. 4). Only with light falling from different sides, the direction of the light being controlled by four light sources, can favourable light conditions be ensured, with the shapes to be treated in this works.

Fig. 8 shows part of the paint drying stove with an overhead conveyor. The stove walls were built during erection, and the ventilation and heating built in so that in spite of the size of the plant, an economical installation was possible. By this means it was possible to satisfy the initially stated, drying requirements of the types of paint used, which necessitate a combination of radiation and convection.

Fig. 9 gives a view of the design of the inside of the furnace, in sofar as concerns the walls and the suspension of the conveyor. The distance between the conveyor lines corresponds to the turning circle of the unfavourably shaped articles at the reversing points. It is possible to walk through the whole drying furnace, which is thus accessible for cleaning.

The combined stove switch cabinet can be seen in Fig. 10. The easily visible arrangement allows rapid setting of the average and heating stages at one control point. Near the apparatus is a door for furnace supervision.

Fig. 11 shows another stove duct. The articles to be dried here are conveyed in an upward direction since no further processing or inspection of the goods occurs on the next section of the chain. The contact-free and consequently damage-free feeding of the freely suspended parts can be clearly observed.

Fig. 12 shows the feed track of the plant shown in Fig. 3, thickly hung with articles. The feed track and the stove drying capacity are very efficiently utilized with this arrangement of the parts. The load on the suspension rods can be considerable

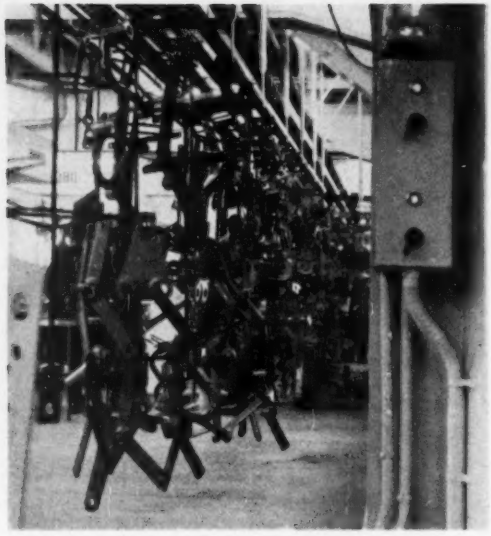


Fig. 12.—Conveyor section closely hung with small parts.

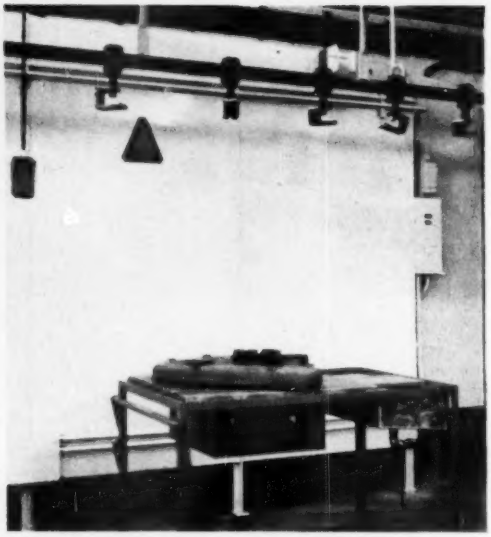


Fig. 13.—Rubbing-down table in conveyor section.

with the cast components to be carried here, which fact had to be taken into account in planning the whole plant and more particularly the goods conveyors.

In Fig. 13 is shown one of the work stations—a rubbing down table. In the continuous flow zone, paint coating is also performed with a brush as this is necessary with parts which cannot be sprayed. These parts are not transferred to the conveyor for spray painting.

Fig. 14 shows some work holders, which are movable and arranged for suspension. It is clear that the parts are accessible for manual operations. With this type of equipment, transportation facilities between the usual hanging cubicles or the drying bays for air drying at room temperatures can be dispensed with. With the multiplicity of parts to be treated, this represents an appreciable saving in transportation cost per man-hour. The designing of equipment of this type is, however, complicated, and requires preliminary basic study of the working cycle and the times involved. In addition, it is highly dependent on the working conditions.

Finally, Fig. 15 shows a unit of the ventilating equipment. Air filtering, heating and circulation are here economically combined in a small space and arranged on the ceiling. By a suitable ducting system it was possible to design an entirely draught-free air circulation, dispensing with the blowing

(*Continued in page 21*)

Fig. 14.—Suspension hooks with separate, movable work-holders.

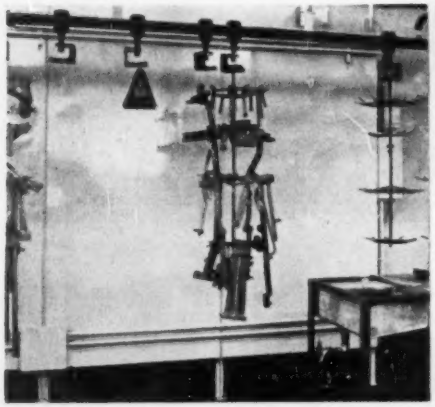
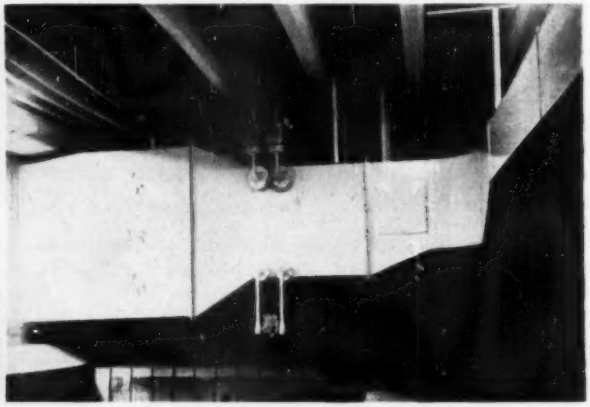


Fig. 15.—Air ventilation unit, of permanent construction.



Purification of Chromic-Acid Solutions by means of Cation Exchangers

by Gunnar GABRIELSON*

Introduction

IN recent years the great interest shown in the purification of chromium plating baths and anodizing solutions by means of cation exchangers, has been apparent from the many published papers dealing with the subject. The process has been made possible by the production of the new, organic ion exchangers, which are copolymers of styrene and divinylbenzene. These are chemically stable and resistant to chromic acid in solution at concentrations up to about 100 gm. CrO_3 per litre. It is the aim of this paper to treat this purification process in some detail with special regard to the dimensioning of the ion exchange layer.

Theory

The cation exchangers which are used in the purification of chromic-acid solutions are of sulphonic-acid type, containing acid groups which are dissociated even in an acid medium. When passing a salt solution through an ion exchanger of this type in the hydrogen form the metal ions are exchanged against hydrogen ions, according to the following formula :

$$R-SO_3H + MeA \rightarrow R-SO_3Me + HA,$$

where $R-SO_3H$ denotes the cation exchanger in the hydrogen form and MeA a metal salt of the monobasic acid HA.

When the resin has been saturated with the metal it is necessary to regenerate it. The regeneration is performed with a strong mineral acid *e.g.* HCl, when the ion exchanger is brought back to the hydrogen form :

$$R-SO_3Me + HCl \rightarrow R-SO_3H + MeCl$$

The ion exchanger is now ready for the next purification cycle.

It is evident that the solution to be treated must not contain more ions than the resin layer can exchange and it is therefore necessary to know the exchange capacity of the resin. The total number of exchanging groups in the ion exchange layer, conveniently expressed as equivalents or milli-equivalents, is called the total capacity of the layer. In column operation, *i.e.* when the solution to be treated is percolated through a layer of the resin, another expression is ordinarily used, namely the break-through capacity. This is defined[1] as the quantity of ions which can be taken up quantitatively by the resin under prevailing conditions, *i.e.* the number of equivalents (or milli-equivalents) which can be retained without any leakage being observed. The break-through capacity is always lower than the total capacity. A break-through curve is shown in Fig. 1, where also the break-through and total capacities are seen.

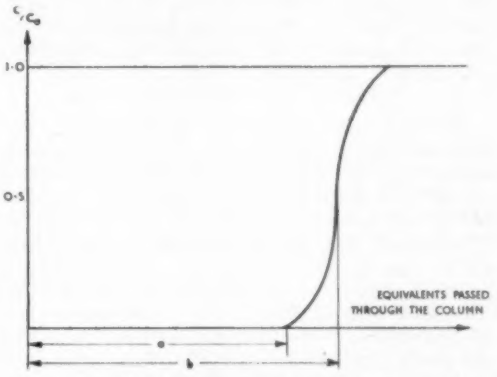


Fig. 1.—Break-through curve of an ion exchange column.
C = the concentration of aluminium in the effluent
Co = the concentration of aluminium in the influent
a = break-through capacity
b = total capacity.

Purification of Chromic-acid Solutions

As mentioned in the introduction some types of modern ion exchangers are stable against chromic-acid solutions up to a concentration of 100 gm. CrO_3 pr litre. This means that anodizing solutions are suitable for purification by this process. Chromium plating solutions on the other hand must be diluted before the ion exchange passage and afterwards concentrated through evaporation. Perhaps the most important use of ion exchange resins in the electroplating field at present is, therefore, the purification of anodizing solutions.

During the anodizing of aluminium, metallic impurities and aluminium are dissolved from the

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anodes into the electrolyte. As the metals dissolved interfere with the anodizing process it is necessary to purify the solution when the aluminium content has risen to about 10 gm. per litre. The old method was to discard part of the electrolyte and add fresh solution, a rather expensive procedure. With the ion-exchange method the chromic acid is completely recovered, a factor of importance to the economy of the process. In addition the metallic impurities are constantly kept to a harmless level.

The purification is performed in the following way. Part or whole of the anodizing solution is pumped continuously or intermittently through a layer of the cation exchanger in the hydrogen form, when aluminium and the other metallic impurities are exchanged against hydrogen according to the following formula :

$Al_2(CrO_4)_3 + 6\ R\text{-}SO_3H = 2(R-SO_3)_3Al + 3\ H_2CrO_4$.

As is seen from this equation the chromic acid is regenerated in the process. The frequency with which the solution is pumped through the resin and how much of the bath must be purified each time, depends upon the rate of dissolution and the maximum allowable concentration of the impurities.

Size of the Resin Layer

The estimation of the size of an ion-exchange layer for the removal of metals from a strongly acid solution is a special problem ; it is not possible to calculate the size of the resin layer from the amount of metals to be removed and the capacity of the resin from a break-through curve obtained when passing a water solution containing the same amount of ions through the resin. The process is complicated by the hydrogen content of the solution ; the hydrogen ions compete with the metal ions for the accessible places in the ion exchanger, or, in other words, continuous regeneration through the hydrogen ions in the solution occurs. The following example from the author's laboratory will illustrate this fact.

A model solution containing 100 gm. CrO_3 and 5 gm. Al (as aluminium sulphate) was prepared. The solution was percolated through a layer of the strongly acid cation exchanger Amberlite IR-120 (Rohm and Haas Co., Philadelphia, U.S.A.) in the hydrogen form. The diameter and height of the resin layer were 80 mm. and 400 mm. respectively, *i.e.* the volume was 2 litres. The flow-rate through the column was 100 ml. per minute. In the filtrate the aluminium content was determined at regular intervals by the potassium fluoride method.[2] The first portions of the filtrate were pale brown but the colour darkened as the metal ions appeared.

Amberlite IR-120 has a capacity of 2 equivalents per litre, the total capacity of the layer used therefore being 4 equivalents or 4,000 milliequivalents. The equivalent weight of the aluminium is 9, so that 5 gm. aluminium (= the content per litre in the model solution) therefore corresponds to $\frac{5{,}000}{9} = 555$ milliequivalents. The resin layer should therefore purify $\frac{4{,}000}{555} = 7.2$ litres, if it is possible to disregard the hydrogen ions, which it is not however. CrO_3 has an equivalent weight of 50, *i.e.* the model solution contains $\frac{100{,}000}{50}$ = 2,000 milliequivalents of CrO_3 and hence of hydrogen ions per litre. The total amount of ions in the solution is therefore 2,555 milliequivalents and hence the resin will purify at most $\frac{4{,}000}{2{,}555}$ = 1.6 litres of the solution. In this connexion it is possible to disregard the fact that the trivalent aluminium ions are more strongly adsorbed to the ion exchange matrix than the monovalent hydrogen ions, which owing to the great concentration differences play a minor role.

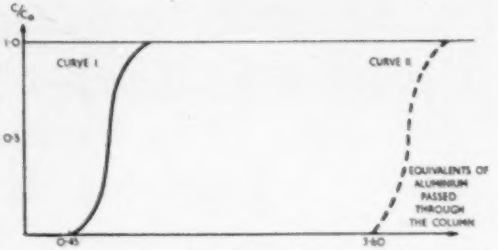


Fig. 2.—Break-through curve for aluminium in a chromic acid solution (curve I) and in a pure water solution (the hypothetical curve II).
C = the concentration of aluminium in the effluent
C_0 = the concentration of aluminium in the influent

The results obtained are shown in Fig. 2, where curve I is the break-through curve for aluminium in the model solution. The break-through capacity is found to be 450 milliequivalents. The theoretical curve II is drawn under the assumption that the aluminium ions are removed from a neutral water solution, with regard to the capacity of the resin layer and the same concentration of aluminium ions as in the model solution. The break-through capacity in this case, when no hydrogen ions are present, is 3,600 milliequivalents of aluminium. For theoretical reasons the hypothetical curve is drawn steeper than the real one. The diminishing of the break-through capacity of curve I in comparision with curve II corresponds, consequently, to the amount of hydrogen ions exchanged from the chromic-acid solution.

(*Continued in page* 21)

Purification of Chromic Acid

(*Continued from page* 20)

Application of Industrial Equipment

Owing to the continuous displacement of aluminium and other metallic impurities by the hydrogen ions in the anodizing bath a comparatively large ion exchange layer is demanded in order to remove also small amounts of impurities. The dissolution of aluminium is, however, rather slow during anodizing and therefore the resin layer need not be prohibitively large.

As an example, with an anodizing bath of 2,000 litres capacity, the current being 2000 amp., according to Faraday's law this current corresponds to about $\frac{2{,}000 \times 24}{27} = 2{,}000$ approx. equivalents per day. Supposing that 1 per cent. of the current as a side reaction dissolves aluminium, then 20 equivalents of aluminium per day, *i.e.* $\frac{20 \times 9}{2{,}000} = 0.09$ gm. Al per day and litre are obtained. If the aluminium content has to be lower than 3 gm. per litre the solution must in this case be purified by the ion exchanger once a month. 2,000 litres of the bath contain $\frac{2{,}000 \times 100}{50} = 4{,}000$ equivalents of hydrogen ions and $\frac{2.7 \times 2{,}000}{9} =$ about 650 equivalents of aluminium ions, the total amount of equivalents in the solution being 4,650. As the total capacity of the resin layer is 2 equivalents per litre, at least $\frac{4{,}650}{2} = 2{,}325$ litres of the resin are required. This means a layer with a diameter of 1 m. and a height of 3 m.

Alternatively 1/3 of the solution may be purified every 10 days when the aluminium content according to the above has risen to 0.9 gm. per litre. This means that 700 litres of the anodizing bath containing 70 equivalents of aluminium and 1,400 equivalents of hydrogen will be purified. A resin layer of 735 litres is sufficient in this case.

As can be seen from the above it is possible to purify an anodizing bath by means of ion exchange in an economical way. The method gives a solution with a permanently low and harmless percentage of metallic impurities. This means better production, both technically and economically.

References

(1). Samuelson, O., Ion Exchangers in Analytical Chemistry, Wiley & Sons Inc., New York 1952, p. 48.

(2). Scott, W. W., Standard Methods of Chemical Analysis, Fifth Ed., The Technical Press Ltd., London 1939, Volume 1, p. 16.

Painting of Machinery Components

(*Continued from page* 18)

of air through a false ceiling, which involves structural adjustments and interferes with the suspension of the conveyors. By this means the ventilating equipment is easily movable and of permanent value.

Conclusions

It has been attempted to show that the static working technique can be considerable relieved, even with the painting of machinery parts, by mechanization of the work cycle and by accelerated drying.

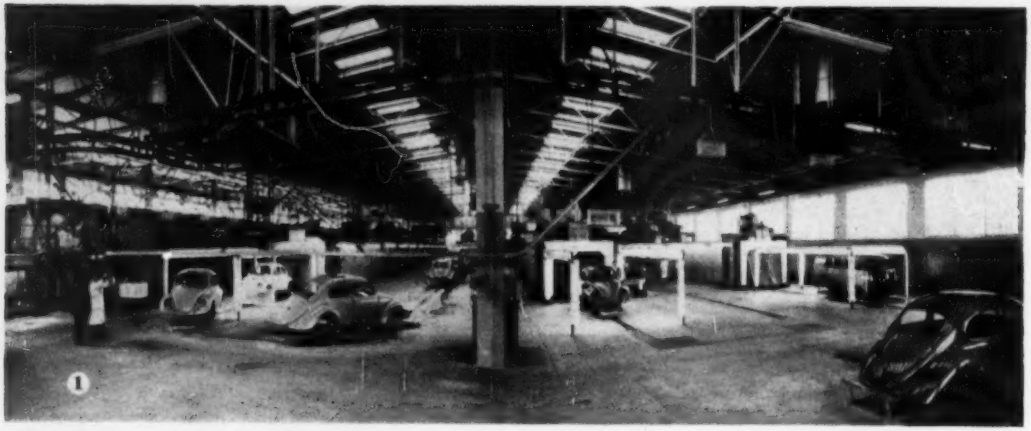
The disadvantages of a static work technique—higher expenditure on manual handling, inconveniently long drying times at room temperature, rapid deterioration in the appearance of the paint coat, etc., can only be remedied in the painting department if suitable equipment is available.

In rationalizing the painting of castings (designing the installation) it must be borne in mind that the necessary flexibility must be maintained unconditionally by suitable planning, allowing for the performance of the work and for the variations introduced in the work cycle. Any mechanization of a work cycle, however advantageous it appears to be, even when favourably executed can produce disadvantages for another work operation or duplication if it is designed as a partial solution, *i.e.* not in relation to the complete production schedule.

This is also the case if, for instance, high-quality covering paints are used which can reduce the number of coats in a paint application but, unless accompanied by a corresponding reduction in the drying times, may lengthen the finishing time or, with paint coats drying more slowly in non-dust-free areas, may cause additional work (dirty paint work, making good, etc.).

Similarly, the transition from brush to spray painting, unless carefully planned, may be uneconomical, as compared with brush painting, due to the high handling costs which may thereby be incurred, or through the excessively long blocking of a spraying cubicle for the subsequent drying, and may result in tedious waiting times. The number of concessions which are often inevitable in view of unfavourable circumstances should be restricted within reasonable standards, if additional costs are not to be incurred which in the present stage of development are entirely avoidable.

As with all basic changes, in the mechanization of the painting of machinery parts, the obvious solution is to test the possibilities in practical production and to find new and more economical ways.



New CAR-BODY FINISHING LINE *for SOUTH AFRICA*

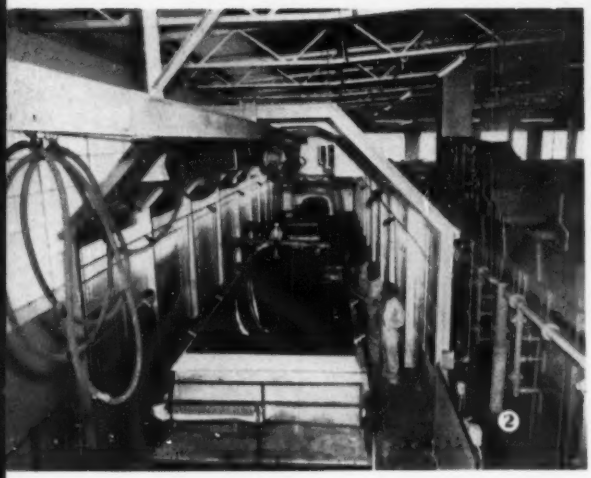
ON August 14, 1958, Dr. Otto du Plessis, Administrator of the Cape Province, officially opened a new paint shop for the finishing of car bodies at the Uitenhage works of South African Motor Assemblers and Distributors. This company is engaged on the assembly of Volkswagen and Studebaker vehicles which are delivered at the factory in the knocked-down condition, and the new finishing line has been the major project in a £500,000 extension scheme, which has just been completed.

The new line, which was designed, manufactured and installed by The Incandescent Group through its South African organization, The Incandescent Group (South Africa) (Pty.) Ltd., incorporates the largest paint-dip tank in the Southern Hemisphere. A general view down the length of the interior of the new shop is shown in 1 above. On the left are the Bonderizing, paint-dip and drain sections and in the centre and on the right the spray booths and the stoving ovens. Bodies are brought into the shop from the adjoining assembly building by overhead conveyor from which they are transferred to a twin-chain flight-bar conveyor whose progress is regulated automatically at 4.8 minute intervals.

The phosphating and prime coating line is some 370 ft. long and is fully automatic in operation except for the prime dipping stage when the body is fully immersed. After degreasing and rinsing the bodies are Spra-Bonderized and subsequently sealed with a hot chromic-acid spray rinse. After drying off in a 3-stage indirect oil-fired oven the body is lifted from the slat conveyor by an overhead air-operated hoist and completely immersed in the prime dip tank. Bodies entering the dip tank are shown in 2 and 3, after which they are placed on a slat conveyor to allow surplus paint to drain off. Stoving of the priming coat is carried out in a 3-stage indirect oil-fired oven. On leaving this oven, bodies are lifted by air-operated hoist on to a high level conveyor for the application of underbody sealer. Thereafter the body is placed on a floor-level conveyor by which it is conveyed to the subsequent processes of finish-coat spraying, stoving, flatting and inspection. In 4 bodies can be seen on the high level conveyor on the extreme right. In the centre is a direct oil-fired oven for drying off moisture remaining after wet-sanding of the first coat. From this oven bodies can be seen entering the second spray booth on the left.

Each of the three spray booths, one of which can be seen in 5, is constructed in an identical manner having a 20-ft. tack-off section and a 30-ft. flash-off section. Exhaust air from the booths is scrubbed by water sprays in baffled ducting before venting to atmosphere. Water from the booths is passed over two banks of coke filters to remove paint over-spray and is stored in a 60,000 gal. reinforced concrete tank for recirculation. Air to the booths passes over three banks of electrostatic precipitators before admission and positive pressure is maintained throughout the booths to prevent access of dust-laden air.

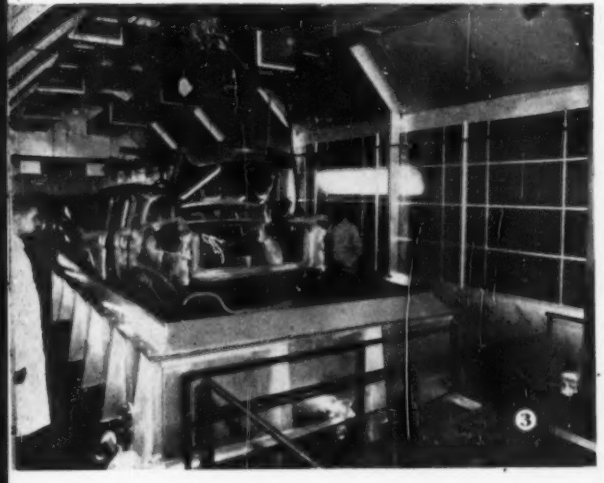
The stoving ovens, which immediately follow the flash-off sections, are each over 100 ft. long and

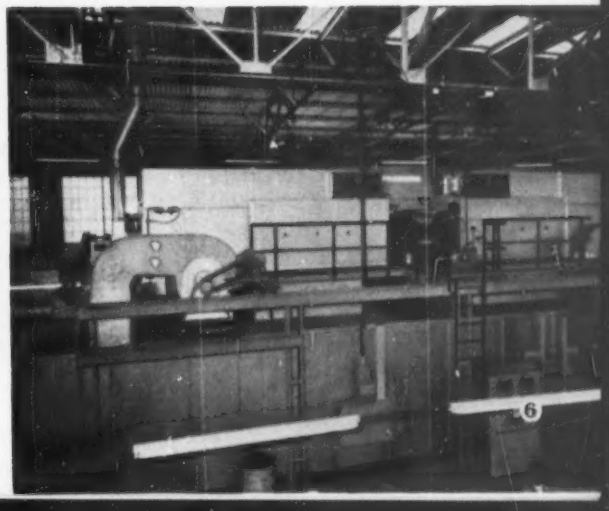


are oil fired, the recirculated air being heated in heat exchangers which can be seen in 6.

The approximate area of the new shop, which is separate from the main assembly buildings, is 60,000 sq. ft. and associated with it are a paint-mix building and a paint store. Particularly stringent fire precautions have been taken, especially in connexion with the prime-dip tank which constitutes a major hazard, as in normal operation it contains 9,000 gals. of paint. Provision is made for dumping the contents of this tank to an underground dump tank outside the shop, while by either manual or automatic operation the enclosed dip area can be blanketed with CO_2 gas.

The whole of the conveyor system for the plant was manufactured by George W. King Ltd.





PLATING OF TITANIUM AND ITS ALLOYS

A Note on American Practice

by T. A. DICKINSON

BY using electrical and electroless plating methods, aircraft and missile manufacturers—like Lockheed, Bendix, Curtiss-Wright, and North American Aviation have solved a number of problems attributable to the surface limitations of titanium and its alloys.

Chromium plating, for example, has been used to eliminate galling and seizing which make the materials difficult to fabricate ; copper and silver plating, to improve solderability and electrical conductivity ; nickel plating to prevent scaling at heat treatment and service temperatures above 1000°F. (588°C) and to facilitate the reclamation of overmachined parts.

Techniques used to plate titanium are not fundamentally different from processes used in finishing other non-ferrous metals. However, they are somewhat complicated by the facts that :

(a) Normal oxide films are rather difficult to remove, and can prevent the satisfactory adhesion of coating materials.

(b) Titanium has a sometimes serious and unpredictable tendency to undergo hydrogen embrittlement when it is plated.

Many metals can be plated directly on titanium surfaces. But since the subject finishes cannot serve their functional purpose if they lack optimum bond strength, copper and nickel are currently regarded as the most suitable undercoating materials. Nickel is commonly applied by the electroless method, while copper is electroplated.

Some authorities contend that electroless nickel plating is not as good as copper electroplating, due to the relative likelihood of hydrogen embrittlement. However, North American Aviation maintain that nickel plating is definitely superior if titanium materials are prepared in such a way that their hydrogen atoms will function as catalytic agents in an electroless solution.

Prior to being plated, titanium is chemically and mechanically cleaned to remove everything except the aforementioned oxide film (which would be replaced, if plating were not done immediately following its removal). Then, if necessary materials are usually masked with molten paraffin or pressure-sensitive plastic tapes—the tapes being preferred where a plating solution contains, for example, chromic acid, which has a tendency to attack or contaminate wax. However, when it is desirable to prevent edge build-up, titanium itself may be used as a conductive masking medium.

Titanium is also used to make most fixtures for the support of materials in plating solutions ; but less expensive metals can serve the same purpose if they are plated with gold, platinum, or some other conductive medium that has comparable acid resistance.

Immediately prior to immersion in a copper or nickel plating bath, titanium materials are given various activation treatments in accordance with their alloying constituents. For example, an activation treatment that has been used by the Lockheed Aircraft Missile Systems Division in processing 4Mn-4Al and 6Al-4V alloys of titanium is :—

(1) Immerse in the following solution at room temperature to evolution of red fumes :
Hydrofluoric acid, 60 per cent ....1 volume
Nitric acid, 69 per cent .....3 volumes
(2) Rinse thoroughly with distilled or deionized water (spray preferably).
(3) Immerse in the following solutions :
Sodium dichromate .....33 oz. per gal.
Hydrofluoric acid 60 per cent, 6.2 fl.-oz. per gal.
Distilled or deionized water : Balance.
Time : 20 minutes.
Temperature : 180°F. to boiling.
(4) Rinse thoroughly in cold running tap water.

Another activation treatment used in connexion with 5Cr-3Al alloys involves the following steps :
(1) Immerse in the following solution at room temperature to evolution of red fumes :
Hydrofluoric acid, 48 to 60 per cent 1 volume
Nitric acid, 69 per cent.....3 volumes
(2) Rinse thoroughly with water.
(3) Immerse in the following solution :
Copper sulphate .....30 oz. per gal.
Hydrofluoric acid, 52 per cent 1.3 fl.-oz. per gal.
Distilled or deionized water : Balance.
Time : 30 seconds.
Temperature : 200°F. to boiling.
(4) Rinse thoroughly with cold running tap water.

Conventional plating baths are used following activation. For instance, satisfactory copper plating

Table I

RESULT OBTAINED IN PLATING TITANIUM ALLOY WITH CHROMIUM

0.005" - 0.007" Chromium Deposited on 4% Mn - 4% Al Alloy. After $Na_2Cr_2O_7$ - HF Pretreatment

Sample	$Na_2Cr_2O_7 2H_2O$ oz./gal.	HF (60) % fl. oz./gal.	Time in Immersion Bath (Min.)	Temp. of Immersion Bath (°F)	Appearance	Steel Ball Indentation Test
1	13	6.2	20	189	Excellent	Fair
2	25	6.2	20	188	Excellent	Excellent
3	25	6.2	20	188	Excellent	Excellent
4	39	6.2	20	190	Excellent	Excellent
5	39	6.2	20	190	Excellent	Excellent
6	52	6.2	20	190	Excellent	Excellent
7	52	6.2	20	190	Excellent	Excellent
8	64	6.2	20	191	Poor	
9	64	6.2	20	191	Poor	
10	33	3.2	10	186	Excellent	Good
11	33	3.2	20	186	Excellent	Excellent
12	33	4.9	10	187	Excellent	Excellent
13	33	4.9	20	187	Excellent	Excellent
14	33	8.1	10	188	Excellent	Excellent
15	33	8.1	20	188	Excellent	Excellent
16	33	9.8	10	189	Excellent	Good
17	33	9.8	20	189	Excellent	Excellent
18	33	6.5	10	188	Poor (Tap water substituted)	
19	33	6.5	20	188	Poor (Tap water substituted)	

has been obtained from non-aqueous baths containing dry lithium hydride, ethyl ether, etc.

Where nickel or copper alone is required, plate thicknesses up to 0.020-in. may be specified ; but, if two or more metals are used, undercoat thicknesses of 0.0010-in. to 0.0020-in. are sufficient to assure the adhesion of additional materials.

Plating intervals for coatings on titanium are approximately the same as the cycles that would be used to produce comparable finishes on steel.

Where two or more plating materials must be applied, it is desirable to transfer titanium articles from one processing solution to another as rapidly as possible in order to eliminate the possibility of contamination.

Following the application of a finish coating like chromium, a post bake may or may not be needed to assure good adhesion—depending on the same considerations that would apply in finishing any metal.

One of the more elaborate titanium plating procedures is currently employed by North American Aviation. It involves the initial deposition of a 0.0010-in. layer of electroless nickel, over which an equivalent deposit of copper is applied as a base for a 0.0020-in. thickness of electroplated silver.

Silver is the principal coating, its purpose being to allow the titanium structural components of

(*Continued in page* 28)

Table II

RESULTS OBTAINED IN PLATING TITANIUM ALLOY WITH CHROMIUM

0.005" - 0.007" Chromium Deposited on 6% Al - 4% V Alloy. After $Na_2Cr_2O_7$ -HF Pretreatment

Sample	$Na_2Cr_2O_7 2H_2$ oz./gal.	HF (60 %) fl. oz./gal.	Time in Immersion Bath (Min.)	Temp. of Immersion Bath (°F)	Appearance	Steel Ball Indentation Test
1	52	6.2	20	188	Excellent	Fair
2	52	6.2	20	188	Excellent	Poor
3	39	6.2	10	188	Excellent	Excellent
4	39	6.2	20	187	Excellent	Excellent
5	25	6.2	10	188	Excellent	Excellent
6	25	6.2	20	188	Excellent	Excellent
7	13	6.2	10	191	Excellent	Fair
8	13	6.2	20	191	Excellent	Fair
9	25	3.2	10	186	Excellent	Excellent
10	25	3.2	20	186	Excellent	Good
11	25	4.4	10	186	Excellent	Excellent
12	25	4.4	20	186	Excellent	Excellent
13	25	7.4	10	186	Excellent	Excellent
14	25	7.4	20	186	Excellent	Excellent
15	25	9.1	10	187	Excellent	Fair
16	25	9.1	20	187	Excellent	Fair
17	39	6.2	10	191	Excellent	Poor (Tap water substituted)
18	39	6.2	20	191	Excellent	Poor (Tap water substituted)

Old-Established Roto-Finish Plant

in operation at the Blackburn Works of BRITISH NORTHROP LTD

by R. C. LIEBMAN

When the Roto-Finish process was first introduced into this country in 1952, one of the earliest firms to install the plant was British Northrop Ltd., Blackburn, Lancs., who operated a large de-burring and finishing department, largely staffed by women, where between two and three hundred different steel components were filed and edged-off after milling and similar operations.

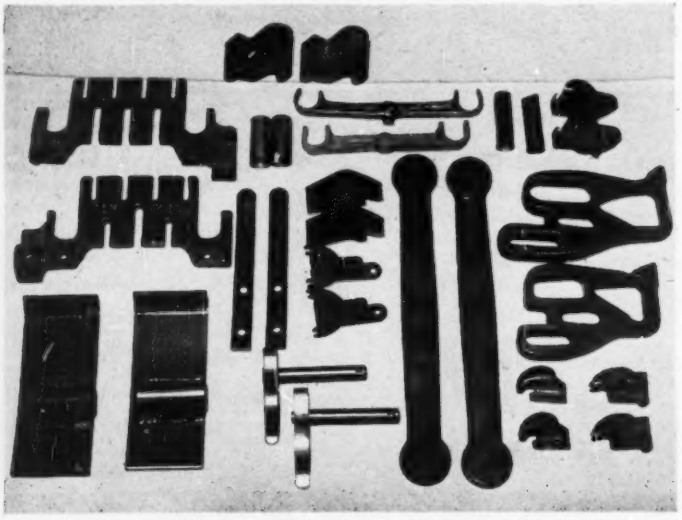
Today, among the many Roto-Finish plants in operation in a wide variety of different industries, the British Northrop installation remains one of the most effective demonstrations of the versatility of the process. This arises from the fact that no other plant in this country uses the process for so many different types of metal ; parts of looms made from phosphor-bronze, copper, aluminium, brass, steel and cast iron are all passed through the four large Roto-Finish DW 30 barrels which stand side by side in the finishing department. An additional advantage in this particular application is that several operations, such as de-burring, de-scaling, profiling, polishing and de-sanding can be carried out all at one time and in the same machine, looked after by only one chargehand, one operator and one labourer.

The Roto-Finish process is the modern version of the old English workshop practice of ' rumbling ' or ' tumbling, ' which has been modified to enable it to be subject to much closer control.

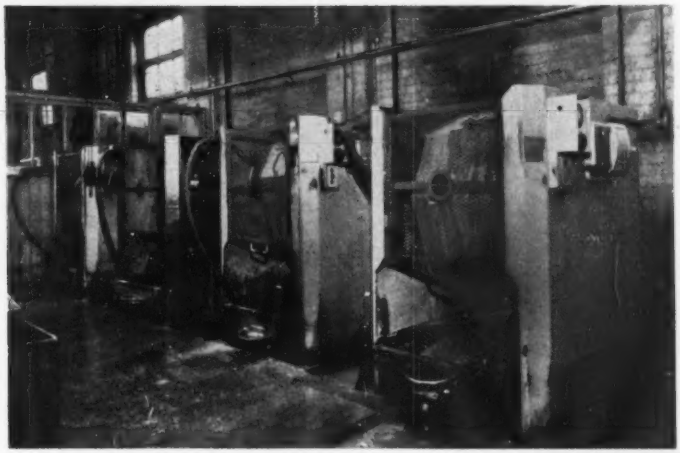
The octagonal, rubber-lined barrels which are the standard basic equipment of the process can be supplied in different sizes, according to the amount of parts requiring de-burring, de-scaling, or polishing, and extra fittings or machines are available to cope with special jobs. In operation, the parts or components to be finished are placed in a mass of specially prepared mineral chips of a size and texture appropriate to the job they are required to do. Selected chemical compounds are added, and apart from them only enough ordinary tap water just to cover the chips and components. The barrel is then rotated for a specific period and at a pre-determined speed, which may vary from 15 r.p.m. to 30 r.p.m.

When the required time has passed, the barrel's outer door is removed, and water and the chemical compound are first drained off through a perforated inner wash-out door. Using the inching button the barrel is then tilted so that the solid contents are emptied into the hoist pan underneath, over which a screen has first been placed to allow the chips but not the components to drop through.

The action inside the barrel is such that adequate contact, pressure and motion is maintained between the part to be processed and the abrasive or polishing particles. A cushioning effect is also achieved so that no component impinges on any other. The mass of chips and components is carried round by the octagonal barrel in a position of repose until the point is reached where the chip mass commences to slide. In practice, this



Some indication of the variety of shapes Roto-Finished by British Northrop is given by the selection of parts of a mechanical loom shown on the left before and after processing.



(left) The battery of four Roto-Finish barrels installed at the Blackburn works of British Northrop Ltd.

(below) The auxiliary aluminium barrel developed for the finishing of very small parts shown being loaded into the standard barrel.

mechanism produces a continuously sliding top layer through which all the components pass.

This circulatory action gives rise to the ultimate removal of the metal, as required, or to the modification of its surface condition. By varying either the speed of circulation, the type of packing or the processing chip—and of course the compound — results can be achieved ranging from harsh cutting down to fine finishing, and the action can be balanced on various facets of the parts. Because of this regular action the process is accurately controlled to give consistent and uniform results on every batch of components processed, without damage or distortion.

Owing to the fact that so many different kinds of metal have to be treated, British Northrop Ltd., unlike many other Roto-Finish users, use five different kinds of chips, and an even larger number of compounds. Up to 20 per cent of their total production of steel loom parts are now Roto-Finished, and the barrels are rotating for a minimum of sixteen hours a day, with many long additional runs at weekends. The average barrel load is 150 lb. per barrel, and normal running times could be anything from six to eighteen hours.

Since the installation of these machines six to eight women's full time labour has been per manently redeployed. The finish is smoother and more even than was being produced by hand and it does not vary in quality between components weighing nine pounds each, in phosphor-bronze, down to tiny aluminium bobbin ferrules, of which 8,000 at a time are put into a barrel in every run. The longest run is given to battery clips, of which 1,500 each are put in two barrels for an entire weekend, from Saturday morning to Monday morning.

An interesting modification of the standard process was developed at British Northrop as a means of overcoming the problem of finishing very small parts. The majority of these parts were centre weft fork wires, which if added to other larger and smaller parts in a barrel-load would have been difficult to separate afterwards, and might even, because of their small size, have dropped through the screen with the chips. This was overcome by making some small, perforated aluminium lightweight casks, which, filled with the smallest size of grinding chip and the centre weft fork wires, and securely fastened are put into the barrel together with larger parts and processed in the usual way. It has been found that the water and compound can circulate freely in the small barrel and its presence causes no interference with the normal action as long as the other parts are made of either steel or cast iron.

FINISHING POST

A SELECTION OF READERS' VIEWS COMMENTS AND QUERIES ON METAL FINISHING SUBJECTS . . . . .

Salt-Spray Testing

Dear Sir,

On page 460 of the December issue of METAL FINISHING JOURNAL we notice with some concern the claim that the new Canning Salt Spray Cabinet for the accelerated corrosion testing of plated and other finishes " enables the relative durability of finishes to be determined." This statement is likely to give the impression that the life of a rust-proof coating subject to normal service conditions of exposure and man-handling can be pre-judged by its behaviour in a salt-spray cabinet. Such is not the case, nor can the relative merits of different coatings be assessed by this method.

In the Journal's report in the same issue, on the recent Symposium of the Institute of Metal Finishing, at which such equipment was exhibited, two speakers, both eminent in this field, made it clear that the value of accelerated corrosion tests is limited and remarked on the erroneous assumptions that can result from a misinterpretation of the results of such tests.

To counteract the impression that may be given by the claim for these test cabinets we feel that it should be pointed out that tests of this nature are of value only for comparing various types and thicknesses of coatings of the same metal or finish, or for determining the relative protection afforded by dissimilar coatings *under the same conditions as exist inside the test chamber.*

Yours faithfully,

F. W. Dishley, Director.

Zinc Alloy Co. (London) Ltd.,
London, N.W.10.

Plating of Titanium

(*Continued from page* 25)

missiles to conduct current in the 200-to 400-megacycle bands, where depth of current flow is 150 to 200 millionths of an inch. However, a final 0.000050-in. thick gold coating is also applied to prevent oxidation of the silver.

Since normal appearance is no indication of quality, plating on titanium is being evaluated with some rather exacting physical tests. One of the simplest and most reliable methods in this connexion is a steel ball indentation test, during which fracture is caused by applying a 2000-kg. load to the plate with a 1/8-in. hardened steel ball (Rockwell H and K scales) with a Brinell-type machine. Quality of adhesion can be rated as follows :

Rating	*Appearance of Fracture*
Poor	Clean break at interface with no plate shear.
Fair	Some plate shear ; little or no residual plating in " bare " area.
Good	Better plate shear, more residual plating in " bare " area.
Excellent	(a) No fracture under 2000-kg. load. (b) Extensive tapered plate shear with many plated spots in " bare " area.

Another test, which is ordinarily used to evaluate copper plating, consists simply of soldering wire to a test specimen and then pulling the wire until a fracture occurs. A deposit is considered satisfactory if no titanium is bared at the fracture.

Diffusion Coatings : Bibliography

(*Continued from page* 11)

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FINISHING NEWS REVIEW

WINNING CAPTION FOR ROSPA PRIZE

FIRST, second and third prizes in the "Caption this Poster" competition, organized by the Royal Society for the Prevention of Accidents as part of last September's industrial safety week campaign, were presented to winners at a ceremony in London's Charing Cross Hotel recently. Cheques totalling £80 were presented by the president of the Society, Sir Howard Roberts, C.B.E., D.L., J.P., to Mr. W. L. Jones, who won both first and second prizes, and Mrs. Hunter, the third-prize winner.

From more than 20,000 entries received for the competition, Mr. Jones' two winners—the one shown above and "He'll tumble to it, tidiness pays"—were selected as best by the judges unaware of the identity of the author. Mr. Jones is employed as a traffic assistant in Murgatroyd's Salt and Chemical Co. Ltd., Sandbach, Cheshire, who have consistently set a high standard of safety for their employees.

Mrs. Hunter is employed in the statistical department of Cadbury Brothers Ltd. in Birmingham. Her entry was captioned "Don't do it yourself." Ten consolation prizes of £2 each were also awarded in the competition.

NICKEL OUTLOOK EASIER

Abundant Supply for Commercial Users

REVIEWING the free world nickel situation during 1958, Dr. John F. Thompson, chairman of the board of the International Nickel Co. of Canada Ltd., said that "dramatic" changes had taken place in the industry, highlighted by abundant supplies of nickel for both civilian and military purposes.

Speaking in Copper Cliffs, Ontario, recently, he referred to the record output attained during the year of about 525 million lb. Consumption of the metal on the other hand had decreased from 415 million to about 330 million lb., and this had led to vigorous competition for new markets. The business recession in the United States and Canada had mainly been responsible for the falling off in consumption, although there had also been a slight decrease in the U.K. and on the continent.

Canadian production during the first eight months of 1958 had run at about two-thirds capacity, but in September labour trouble in the company's Ontario mines and plants had sharply reduced even this rate.

Referring to the future, Dr. Thompson said that it was expected that free world production of nickel two years hence would be about twice the 1958 consumption so that consumers who had been forced for a protracted period to curtail their use of the metal could now look forward to a steady and abundant supply.

"The stainless steels accounted for the largest use of nickel by the steel industries in 1958," he said. "During 1958 the total production of stainless steel dropped substantially but the percentage of the nickel-containing grades showed some increase relative to the total."

In the United Kingdom the use of nickel for electroplating showed an increase. Automotive producers in the United States have increased the thickness of the nickel plating underlying the chromium; in industrial applications, important advances included the use of relatively thick nickel deposits on processing and transportation equipment to prevent product contamination, and electroforming of such special products as hypersonic wind tunnel nozzles, grids, screens and special moulds. Another application indicating potential growth is the bright nickel plating of aluminium products. In applications where the inherent light weight of aluminium is an advantage, a protective surface can be provided by nickel-chromium plating.

"PENNSALT" PRODUCTS, TRADEMARKS, FOR CRUICKSHANKS

IT was announced recently that R. Cruickshank Ltd. of Camden Street, Birmingham, chemical manufacturers and metal finishing specialists, and the Pennsalt International Corporation S.A. have now reached agreement under which R. Cruickshank Ltd. has been granted exclusive licence for the manufacture and sale in the U.K. of a wide range of Pennsalt products for the metal industries, and for the sale of these products in certain overseas countries. By agreement with the Pennsalt Chemical Corporation, U.S.A., licence to use the Pennsalt trademarks has also been granted.

A HAPPY AND PROSPEROUS NEW YEAR

The Editors, the Advertisement Director and the Staff extend to all readers, advertisers, contributors and other friends in the industry at home and overseas, sincere and cordial good wishes for their happiness and greater prosperity in the year that lies ahead.

BARD & WISHART MOVE

FORMERLY at 26 Brown Street, Manchester 2, Bard and Wishart have now moved to new premises at Parkside Road, Sale, Cheshire. Telephone: Sale 4624. The company says that this new sole address should be used for all correspondence as well as the delivery of goods now on order.

POWDER SPRAY IS RUST INHIBITOR

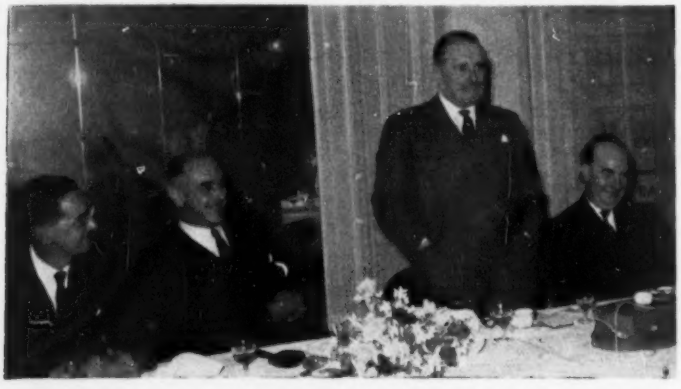
HUNGARIAN research chemists have recently perfected an evaporating rust and corrosion inhibitor, according to a recent report from that country. A simpler manufacturing process allow the inhibitor to be produced much more cheaply than "the product introduced during the last war by the Americans and known as VPI."

Sprayed on to metal as a white crystalline powder, it quickly evaporates, leaving the surface covered with a uni-molecular film that has a high resistance to corrosion; it has even greater effectiveness when impregnated in wrapping paper, the report claims.

Two cases of metal parts were despatched to China; in one case conventional greased paper wrappings were used and in the other the parts were protected with wrapping paper impregnated with the new inhibitor. A year later the cases were returned and on opening it was found that although the parts packed in the greased wrappings had rusted, the inhibitor impregnated wrappings had given full protection. A patent for the process has been granted.

COL. CHINSTRAP MEETS FINISHERS

"THE value of alcohol as a levelling agent" was the subject discussed with considerable expertise by the redoubtable Col. Chinstrap at the Christmas meeting of the Finishing Luncheon Club at the Rembrandt Hotel on December 18. Seen below watching Jack Train do his famous characterisation are (*l. to r.*) Mr. F. J. Potter, general secretary of Dr. Barnardo's Homes, Mr. J. N. T. Adcock, deputising for Mr. W. F. Wilson, chairman of the Club, and Mr. John Hooper, hon. secretary of the Club. During the proceedings a cheque for £50 was handed to Mr. Potter as a contribution from members.



T.R.I.'s Dusseldorf Meeting

German Conference on Tinning Cast Iron

A NEW method of tinning cast iron was described at the Tin Conference held in Dusseldorf at the end of November, and organised by the German office of the Tin Research Institute.

In a paper on hot-tinning cast iron, presented by Dr. E. S. Hedges, director of the International Tin Research Council, the direct chloride process developed by the Institute at Greenford was outlined. Readers may remember that the process was described in the December, 1956, issue of this journal.

The process has the advantages of simplicity, ease of operation and consistency in the final result. Inexpensive iron castings can be easily tinned to give a strongly made article with a bright, hygienic and pleasing finish. Cast iron bearing shells can be hot-tinned before casting on the bearing metal and consistently good bonds between the iron and the white metal can be obtained without the use of keyways.

The Dusseldorf Conference was under the chairmanship of Herr M. Benscheid, chairman of the German Domestic Machinery Industry Association, and was opened by Dr. W. E. Hoare, assistant director of the Tin Research Institute, who described modern developments of hot-tinning techniques in industry.

Other speakers at the conference were Dr.-Ing. B. Keysellitz, head of the Tin Research Institute's German office, who discussed the maintenance of hot-tinning baths, and Dr. R. Kuhn of Frankfurt, who described the American Kolene hot-tinning process.

Mr. W. E. Wright

IT is with profound regret that this journal reports the death on Thursday, December 11, of, Mr. William Elkington Wright F.C.S., until recently a director of The Pyrene Co. Ltd., responsible for the metal finishing division.

Bill Wright joined The Pyrene Co. Ltd. nearly 30 years ago and pioneered in this country the use of phosphate coating processes on a production scale. Wide scale use of these processes today is a continuing reminder of his foresight.

Mr. Wright, who had been in failing health for several years, retired from the board of directors at the close of 1957. His profound knowledge and helpful advice, however, continued to be available to all his colleagues to whom his passing is a very sad loss.

"STELVETITE" IN LONDON SHOW

Royal Festival Hall Exhibition in January

AN exhibition on the fabrication and application of "Stelvetite" plastic-coated steel sheet, is being held at the Royal Festival Hall, London, from January 13-16, by the manufacturers, John Summers and Sons Ltd., of Shotton, Chester.

A series of demonstrations will include spot-welding (done without damage to the P.V.C. coating), high-frequency welding, lock-forming, printing and drum-sealing.

Stelvetite in all its available colours and gauges will be shown with a large selection of the things now being produced in the material, such as office furniture and machines, chemical equipment, refrigerators, domestic water-heaters and clocks.

Admission to the exhibition will be by invitation only except on the last day (Friday) when it will be open to persons holding tickets obtainable upon application from the company at St. Ermin's, Caxton Street, London, S.W.1.

GENERAL MANAGER FOR V.E.D.C.

The Vitreous Enamel Development Council recently announced the appointment of Mr. Ken Jones as general manager. After training in building management at Regent Street Polytechnic, and subsequent service with the Royal Engineers, he joined Richard Costain Ltd as a surveyor contracts manager. In 1956, he became a development engineer with the Northern Aluminium Co. Ltd., concerned with aluminium enamelling. The VEDC have obtained new premises at 28 Welbeck Street, London, W.1. Telephone : Hunter 2237.

Brussels Awards For British Paint Makers

EXHIBITING on the Birmingham Exchange and Engineering Centre Group Stand at the recent Brussels World Exhibition, Detel Products Ltd., Victoria Park Estate, South Ruislip, Mddx., were awarded a Diploma of Honour in the "Protection of Metal against Corrosion" class. The Engineering Centre collective exhibit won a bronze medal for "Pigments, paints, varnishes and artists colours."

Ray-Heet is New Member of Vokes

IT was announced recently that Ray-Heet (Infra-Red) Ltd. has become a member of the Vokes Group of Cos., and will trade under the new name of Ray-Heet (Process Plant) Ltd. with offices at Rayleigh House, High Street, Great Bookham, Surrey. Telephone : Bookham 3108.

The company will now have available all the facilities of a modern factory and well-equipped research laboratories, together with a world-wide sales organisation, thus enabling them to substantially widen the scope of their activities. Included in the range of equipment made by the firm are degreasing and pre-treatment plant, spray-booths, and many other items used in paint finishing systems.

INDUSTRIAL FILM FESTIVAL

Film entries for the second industrial film festival to be held at Harrogate from April 21-24, are invited from sponsors and all producers concerned with films for industrial purposes.

Those interested are asked to apply to the secretary at 3, Portman Chambers, 7/9, Baker Street, London, W.1.

KEY OF THE DOOR FOR GRAHAM FIRTH

THE 21st anniversary of the foundation of the firm of Graham Firth Steel Products Ltd., Brockhurst Works, Bescot, Walsall, was celebrated at a dinner held at the Trocadero Restaurant, London recently. Chairman of the company, Mr. E. H. King, occupied the chair and the other directors present included the managing-director, Mr. L. Graham Firth, Mr. B. J. Byrne, Mr. A. R. Lancashire and Mr. A. R. Rees-Reynolds.

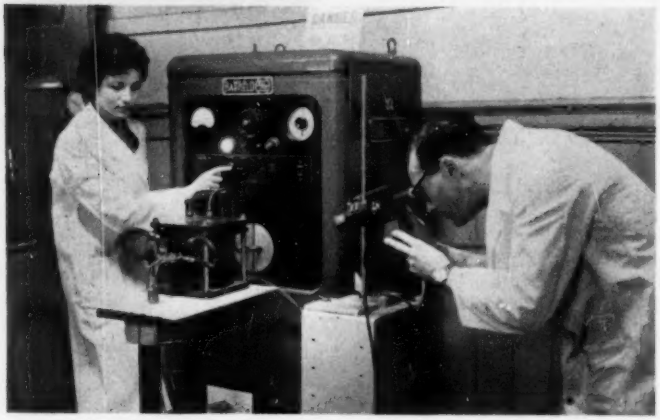
DINNER FOR CANNING'S SALES STAFF

A sales conference was held in Birmingham by W. Canning and Co. Ltd., at the end of November, attended by sales staff and executives from Birmingham, London and Sheffield. At the conclusion of the conference a dinner was held at the Queens Hotel, Birmingham, at which Sir Ernest Canning, until recently chairman of the company, presided. The photograph shown below was taken during the dinner.

METALLIC SURFACE TREATMENT

New Offices and Improved Research Facilities

JUST over two years ago, in October 1956, Metallic Surfaces Research Laboratories Ltd. was founded. The firm specializes in surface treatments of metals and other engineering materials, more particularly in non-electrolytic methods of protecting surfaces, and a consulting and research organization for these processes was set up in premises on the first floor of the Market House, at Uxbridge, Middlesex.



Above — The 3 kw high-frequency heating unit

Last month, at an informal reception attended by many well-known figures in the metal finishing world, the company celebrated its first expansion ; in a little over 24 months the company has grown to more than double its original size, so that the laboratories and office accommodation now take up the whole of the first floor of the Market House, comprising some 6,500 sq. ft. Directors of the company are R. L. Samuel, Ing. Chim., A.I.M. ; N. A. Lockington, M.A., A.R.I.C., A.I.M. ; D. G. Griffiths and J. D. Samuel ; the company secretary is Mr. W. G. W. Griffiths.

During these first two years, work has been carried out on research programmes dealing with the protection of materials against oxidation at elevated temperatures, corrosion-resistant coatings for ultra-high tensile steels, fundamental investigation of metallic diffusion under high-frequency heating conditions, and in various other projects sponsored by private industrial concerns.

In addition, considerable effort has been devoted to the development of commercial metallic diffusion processes such as chromizing, siliconizing, and alloy coatings. A subsidiary company, Metallic Surface Developments Ltd., has been formed to provide a licensing medium and technical service for users of the processes evolved by the research unit.

Diffusion coatings are now being used on an increasing scale in modern engineering, especially in the fields of gas and jet turbines, and in nuclear engineering, where materials that adequately combine strength in the mass and chemical stability at the surface are required. The continuous, unstrippable coating that can be obtained by the diffusion process on a wide range of metals allows the designer to select a material having the most suitable physical properties for the application required, and then to protect its surface against corrosion, oxidation, and wear.

Below — The vacuum metal deposition unit and part of the corrosion section

To achieve diffusion of most elements into metals by surface reaction, the energy required by the process can be conveniently provided by heat, and most diffusion methods are carried out at comparatively high temperatures. The diffusion mechanism is a purely physical effect depending upon the concentration of the diffusing metal at the surface of the metal to be treated, and upon time and temperature ; the coatings can be obtained in a number of ways depending upon the method chosen for applying the diffusing metal to the surface.

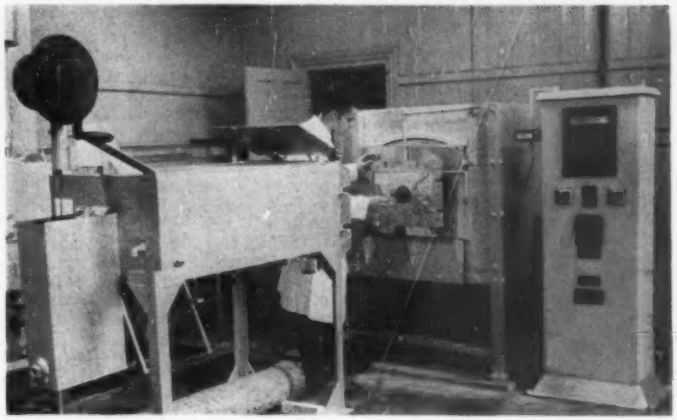
The process consists of two stages : surface reaction or deposition ; and diffusion. As an example, zinc applied to a steel surface by any of the well-known methods can be heated to a suitable temperature in a non-oxidiz-

LABORATORIES' RAPID GROWTH

Double Size of Uxbridge Firm in Two Years

ing atmosphere to form an alloy coating on the steel. The two stages of the process can be combined by heating the steel workpiece in contact with zinc powder and a diluent, when a similar diffusion coating to the first can be obtained. A widely used method of deposition and diffusion is based on the reaction of a halide of the diffusing metal on the solvent metal at elevated temperature, and a typical example of this method is chromizing.

The hardness of chromized coatings can vary from 200 VPN for iron or low carbon steels to 1500 to 1800 VPN on high carbon steels. Coatings obtained with low carbon steel have good ductility and can be subjected to mechanical deformation such as rolling and pressing, so that sheet steel blanks can be chromized before forming operations are undertaken. Chromized steel can be welded, preferably using austenitic stainless steel welding rods with arc or gas welding, although spot and resistance welding can also be used. The chromized coating of a low carbon steel is a high chromium ferritic iron of average 22 to 25 per cent chromium. The surface concentration of chromium is higher, nearer to 50 per cent., so that the behaviour of such coatings, particularly to dry corrosion, is usually better than an average chromium stainless iron. The selection of a special steel, such as titanium-stabilized low carbon steel, improves considerably the resistance to wet corrosion.

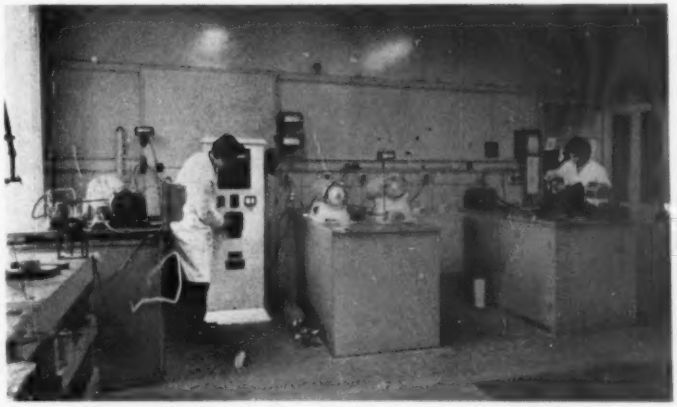


Above — Pilot plant for metallic diffusion processing

Aluminium diffusion (calorizing) can also be obtained by heating the parts in contact with a compound containing powder aluminium, a refractory filler and a small proportion of ammonium chloride in a rotary retort. A treatment of 4 to 6 hours at 850° to 900°C. produces a coating of 0.002 to 0.005 in. containing about 60 per cent. aluminium. Its major industrial value is in providing a surface coating having a high resistance to thermal oxidation and to thermal corrosion in the presence of sulphur-bearing gases. It is not used for corrosion prevention. Usually, only finished articles can be calorized since the coating is not really ductile, and one typical application would be for bolts for high temperature use.

At the Uxbridge premises, the administrative section is housed at one end of the building and the laboratories are divided into the following sections :— *Metallography:* with facilities for photomicrographs, micro-hardness testing, etc., of ferrous and non-ferrous metals and alloys. *Chemical analysis :* equipped for volumetric and gravimetric analysis of metals, alloys, coatings etc. *Electro-chemistry and corrosion :* electro-plating, -pickling, -polishing equipment and fittings for atmospheric, salt-water, salt-spray corrosion testing. *Thermal oxidation and corrosion :* this section includes thermostatically controlled vertical tube furnaces, gas oven, thermal-shock flame impingement apparatus and all the ancillary equipment required for the study of oxidation and corrosion at elevated temperatures. *Physical testing :* the equipment available is designed for the study of surface treatments in relation to physical properties of the materials and includes : hardness testing apparatus ; tensile machine for room-temperature and high-temperature testing on small

(*Continued in page* 34)



Below — A section of the furnace room

Metallic Surface Labs.

(*Continued from page* 33)

specimens. The equipment is fitted with rigs for sheet metal tensile testing, compression tests, cupping (Erichsen) and bending tests, slow-bending notch test, etc. A complete section is devoted to the study of the brittle fracture of ultra-high tensile steels under constant stress and includes some 18 specially designed rigs where specimens coated with a variety of protective finishes and stressed to near maximum tension, are subjected to corrosion, friction and electric discharge. Rotating beam, single-point loading cantilever equipment is available for fatigue testing at room temperature and up to 1000°C. *Heat-treatment and processing :* this is the largest section of the laboratories. It incorporates conventional heat-treatment furnaces :—gas oven, salt-bath furnace.

The experimental processing benches are equipped with horizontal electric tube furnaces and miniature retorts which can be operated at atmospheric pressure or with vacuum pumping equipment. A modern vacuum deposition unit has now been installed, capable of depositing metals by evaporation or sputtering under high vacuum. The apparatus is to be fitted with internal heating devices and with a furnace for vacuum melting.

A 3 kW high-frequency heating unit is operating and is used for fundamental research on metallic diffusion and also in conjunction with forging equipment for the development of lubricant and protective coatings for the deformation of some metals and alloys at high temperatures. Finally, a complete pilot-plant and demonstration unit has been installed for metallic diffusion processes, including improved methods of chromising, etc. The thermostatically-controlled, electrically heated plant, has a retort capacity of approximately 20 in. x15 in. x 9 in. and includes all the patented features available for full-scale commercial operation.

Fire Bulletin

A bulletin on fire protection for small businesses is now available free of charge from the Fire Protection Assn., Garrard House, Gresham Street, London, E.C.2.

TECHNICAL BOOKSHELF

Electrodeposited Metallic Coatings. Compilation of Standards B-8. Philadelphia : 1958. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 124 pp., $2.25.

THIS compilation of ASTM Standards covers such materials as electrodeposited zinc, cadmium, nickel, chromium and lead for steel. In addition, coatings for copper, copper base alloys, zinc and zinc base alloys are also covered. The work supersedes the previous issue made in 1955.

Local thickness, acetic acid, and salt spray tests are included in the volume, as also are recommended practices for preparing metals for plating. These include plating for low carbon steel, high carbon steel, aluminium alloys, zinc base die castings, iron castings, etc.

In all, the book contains seven specifications, three methods of test and nine recommended practices. Of the total 19 standards, five are new, recently revised or have had their status changed within the year.

I.C.I. and the Comet

THE Metals Division of I.C.I. is supplying titanium for components in the Rolls-Royce " Avon " R.A. 29 engines and for several major structural assemblies used in the Comet IV. These include top skinning over inner and outer engines, transverse and spar bulkheads, engine seal rings, rear air intake ducts, engine cowl doors and fire-walls.

Marston Excelsior Ltd., an I.C.I. subsidiary, is supplying heat exchangers and " Marlite " flexible fuel tanks.

STURTEVANT'S CORROSION DEPT.

A CATHODIC protection department has been formed by Sturtevant Engineering Co. Ltd. Headed by Mr. J. H. Morgan, who has recently joined the company, the department will make available on a commercial basis this method of safeguarding ships' hulls, metal piling, buried pipework etc., against corrosion. All enquiries should be addressed to the company's head office at Southern House, Cannon Street, London, E.C.4.

NEW JOURNAL LISTS PATENTS

FIRST issue of a new publication—" *Lapis—Industrial opportunities*" —appeared recently, published by Kenneth Mason, 1 Old Burlington Street, London, W.1.

The publication is in two parts, A-General, Mechanical and Electrical, and B-Chemistry and Chemical Engineering. Appearing monthly, *Lapis* will list, on an international basis, patents for disposal by licence or sale. The journal aims to give as much condensed detail of each product listed as is possible, and descriptions will be couched in non-technical terms. The editorial states that, to begin with, advertising will not be accepted, and that the journal will depend entirely upon subscriptions at 10 gns. per annum in the U.K.

The first number contains some interesting extracts from " The Sources of Invention," published by Macmillan and Co., London. One of these states that two-fifths of the patents issued in the United States and Great Britain are still issued to individuals, and another that if inventions ever became the prerogative of full-time professional employees there are grounds for believing that industrial development would be weakened in consequence.

"GREAT LAKES" EUROPEAN SALES OFFICES

WITH sales offices at 140 Park Lane, London, W.1., Great Lakes Carbon International Ltd., has been appointed sales representative for all commercial products of the new Anglo Great Lakes Corporation Ltd.'s graphite plant at Newcastle-upon-Tyne. In addition, the firm will also market graphite products of the Great Lakes Carbon Corporation, U.S.A., throughout the U.K. and Western Europe.

The products comprise an extensive line of high quality graphite electrodes, graphite anodes and graphite specialities.

Mr. Charles H. Harrison, European sales director, and Mr. Cyril G. Conway, sales engineer, are conducting the firm's sales activities.

PHYSICAL SOCIETY EXHIBITION

Swedish Engineering Research Instruments on View

THE Physical Society's 1959 Exhibition to be held from the 19-22 this month, in the Old and New Halls of the Royal Horticultural Society is the 43rd in the series, and will include 153 exhibitors representing a cross section of the latest developments in British physics.

The policy of the Society is to show as many new instruments and techniques as possible. and it is hoped that the 1959 exhibition will maintain and exceed its previous high standards. A large number of universities, hospital physics departments and research organizations are again participating, thus assuring a high proportion of purely research exhibits. As is usual, exhibits will show the trend of instrumentation in industry, research and teaching for the next twelve months.

Visitors to the exhibition will be interested in the selection of instruments from Swedish universities and research organizations, shown this year by invitation of the Council of the Physical Society. The Swedish exhibit is under the auspices of the Royal Swedish Academy of Engineering Sciences.

The scope of the exhibition is very wide and includes such items as fully developed instruments for the tracking of artificial earth satellites. Another recent advance in technology — the automatic factory with the requisite complex control of machine tools — is well represented by the various forms of diffraction gratings and their applications to the accurate positioning of tools. Such new introductions as the Maser, for microwave techniques, are shown for the first time this year.

BICC-TELCON AMALGAMATION

CO-OPERATION between British Insulated Callender's Cables Ltd. (BICC) and the Telegraph Construction and Maintenance Co. Ltd. (Telcon), particularly in certain countries overseas and on special technical problems, has been growing steadily over the last few years.

The directors of both companies now think that a unification of their interests is desirable, and an independent firm of chartered accountants, Thomson McLintock & Co., have been investigating the basis upon which the respective interests might be merged. As a result, it is now proposed that BICC should make an offer to acquire the entire share capital of Telcon on an exchange of shares basis and that Telcon with its fine name and long tradition should continue as a separate entity within the BICC Group, according to a recently issued joint statement.

The statement adds that the main potential benefits to both companies are the broadening of their base on the metals side, their respective interests in these fields being complementary to each other ; the benefits which can accrue through a co-ordination of research and development effort and the rationalisation of production and sales in fields in which both companies are interested, and the complete co-ordination of their interests in overseas investments.

The development of polythene powder coatings marketed by Telcon was described in the October issue of this journal.

"Araldite" Down

Substantially lower prices for "Araldite" epoxy resins have been announced by CIBA (A.R.L.) Ltd. (formerly Aero Research Ltd.). The reductions have followed immediately upon the completion of a new epoxy resin factory at Duxford with a greatly increased production.

MEETINGS OF THE MONTH

January 19

Institute of Vitreous Enamellers (Midland Section). "Recent Enamelling Development," by J. Semple, at the Exchange and Engineering Centre, Stephenson Place, Birmingham.

January 30

Institute of Vitreous Enamellers (Midland Section). Annual general meeting and dinner, at the Station Hotel, Dudley.

January 22

Society of Chemical Industry (Corrosion Group). Conversazione, at the Battersea College of Technology, Battersea Park Road, London, S.W.11. 6.30 p.m.

January 27

Society of Instrument Technology (London Section). "Symposium on Flow Measurement," by R. E. Fischbacher, P. Scanes, B. W. Balls, E. E. R. Sams and F. R. Allen, at Manson House, Portland Place, London, W.1. 5.30 p.m.

February 3

Institution of Chemical Engineers (N.W. Branch and Graduates and Students Centres). "Effluent Disposal and Air Pollution," in the Chemical Engineering Building, Manchester College of Science and Technology, Jackson Street, Manchester. 3 p.m.

February 6

Society of Instrument Technology (Fawley Section). "Laboratory and Industrial pH Measurements and Titrations," by G. Mattock, at Copthorne House, Fawley, Hants.

February 7

Institution of Chemical Engineers (Midlands Branch). Annual General Meeting. "Principles of Selecting Dimensional Systems and Units in Chemical Engineering," by A. Klinkenberg, at the College of Technology, Gosta Green, Birmingham. 2.30 p.m.

February 10

Institute of Vitreous Enamellers (Scottish Section). Short Papers : "Enamelling Cast Iron," "Enamelling Sheet Iron," "Iron for Enamelling," "Production of Castings," and "Abrasives," at the Plough Hotel, Stenhousemuir.

February 11

Society of Chemical Industry (Corrosion Group). "Recent Research on the Corrosion of Tinplate," by S. C. Britton and K. Bright, at the Society's premises, 14 Belgrave Square, London, S.W.1.

February 12

Institution of Chemical Engineers. Symposium on Mass Transfer, at Church House, Westminster, London, S.W.1. 9.30 a.m.

February 16

Institute of Vitreous Enamellers (Midland Section). "Architectural Enamels," by T. J. McArthur, at the Exchange and Engineering Centre, Stephenson Place, Birmingham.

February 18

Institute of Vitreous Enamellers (Southern Section). "The Future of Cast Iron for Vitreous Enamelling," by J. Bernstein (Simplex Electric Co. Ltd., at the Howard Hotel, Norfolk Street, London, W.C.2. 7.15 p.m.

TECHNICAL *and* INDUSTRIAL APPOINTMENTS

G. A. Harvey and Co. (London) Ltd., have recently made the following staff appointments :

Mr. K. Tardif, publicity manager, has now taken over the duties of home sales manager and will continue to work from the company's head office at Greenwich. Mr. H. Barker, formerly deputy sales manager, has been appointed export sales manager and will also work from Greenwich. Mr. H. F. Jones has been appointed London area manager controlling the company's London sales office at 58, Victoria Street, London, S.W.1.

* * *

The appointment of Mr. Peter J. Verlinich as director of public relations of the **Schaffner Mfg. Co. Inc.,** Schaffner Centre, Pittsburgh 2, Pa., was announced recently.

Mr. Verlinich was formerly associated with the Rockwell-Standard Corpn. for twenty-two years, in the capacity of supervisor in the finishing of ferrous and non-ferrous metals, and is an authority on many finishing processes.

At the same time, the election of Mr. James R. Schaffner to be secretary-treasurer of the corporation was announced.

Mr. James R. Schaffner, after completing an extensive research programme, was assigned to sales under the direction of Mr. Paul E. Schaffner. He will continue his interest in sales together with his new responsibilities.

* * *

Mr. W. Forbes Ritchie, until recently chief engineer of the **Consolidated Pneumatic Tool Co.** at Fraserburgh, has been appointed manager of factory operations, a position recently created.

In recent years the company has augmented its output at Fraserburgh by a further large factory at Aberdeen, an extension of production in South Africa and the opening of a new manufacturing unit in India, in addition to existing plants on the continent and in Australia. Mr. Ritchie will be responsible for the overall supervision and co-ordination of manufacturing operations in these areas.

A Fraserburgh man, Mr. Ritchie joined the company in 1937 as an apprentice and spent two years in the machine shops. In 1939 his training continued in the drawing office until joining the R.A.F. in 1942. Returning to the company in 1946, he subsequently joined the newly formed engineering department at Fraserburgh. He was placed in charge of this department in 1956, and in 1957 was appointed the company's chief engineer.

* * *

Mr. F. L. Gibson, who joined **Wolf Electric Tools Ltd.,** Pioneer Works, Hanger Lane, London, W.5., eight years ago, has now been appointed sales manager for the home market.

He has previously been a technical representative and a divisional executive, and has been closely associated with the portable electric tool industry for nearly twenty years.

Mr. K. A. Clark

Dr. H. J. Pick has left Birmingham University to join **Joseph Lucas (Electrical) Ltd.,** as Senior Physical Metallurgist.

* * *

The **Jenolite Group of Cos.** have appointed Mr. Desmond van Zwanenberg as manager of Allied Distributing Corporation Ltd. and Jenograph Ltd.

Formerly area manager of Deosan Ltd. (one of the Milton Group of Companies), Mr. Zwanenberg has a wide experience of sales organization.

Mr. K. A. Clark has been appointed senior sales co-ordinator of the group to augment distribution of products and improve technical servicing facilities. Mr. Clark has had considerable experience of the technical field and of sales organization methods both here and in the United States.

* * *

Mr. O. C. Davies, former manager of the Lydney tinplate works till they closed just over a year ago, has been appointed manager of the new basic slag works now in course of erection by the **Steel Co. of Wales** at Port Talbot.

* * *

The retirement is announced of Major C. J. P. Ball from the boards of British Resin Products Ltd., Distrene Ltd. and British Geon Ltd., the three companies which form the **Distillers Plastics Group.**

Mr. T. F. A. Board, a director of the Distillers Co. Ltd., has been appointed chairman of British Geon Ltd. and of Distrene Ltd.

Mr. H. H. Woolveridge, who is chairman of the Distillers Plastics Group, has been elected chairman of British Resin Products Ltd. and Mr. P. A. Delafield, who is managing director of the same Group, becomes managing director of British Resin Products Ltd.

Mr. D. Van Zwanenberg

It is announced that the board of the newly formed company—**Birlec-Efco (Melting) Ltd.**—comprises Mr. George P. Tinker (chairman), Mr. J. C. Howard (managing director), Mr. F. S. Leigh (assistant managing director), Mr. D. L. Campbell, Mr. J. H. Crossley, Mr. P. F. Hancock, Mr. J. A. Monks and Mr. T. G. Tanner. The secretary of the company will be Mr. J. C. Mantell.

The company has been formed by Birlec Ltd. and Efco Ltd. for the design and supply of all types of electric melting furnaces.

* * *

Firth Cleveland Tools Ltd., Tipton, Staffs., a member of the Firth Cleveland Group, have announced the appointment of Mr. F. A. Field as general sales manager. For many years Mr. Field held a similar executive position with Black and Decker Ltd.

(*Continued in page* 37)

BIM-POLY EXEC. COURSE PLANS

Smaller Firms Using Management Courses

THE department of management studies of The Polytechnic, Regent Street, London reports that during 1958 an increasing number of medium and smaller sized firms became interested in their 4-week residential executive programme for management development.

Although the majority of firms sending executives to the courses were large, for example, the Dunlop Rubber Co., Imperial Chemical Industries, British Nylon Spinners Ltd., Joseph Lucas Ltd., the requests for places from smaller businesses steadily grew.

To meet the demand, the Department will run three programmes in future. In 1959, these will start on February 2, April 13 and November 9. Applications can be made now, the department says.

At the courses, in addition to the Polytechnic staff, a visiting faculty of twenty senior managers and specialists take individual periods on specific aspects of practical management problems. Among the visiting lecturers on the last course were : Lord Luke (Bovril Ltd.), Col. L. F. Urwick (Urwick, Orr and Partners), Mr. W. B. D. Brown (The Glacier Metal Co.), Mr. Caspar Brook (Consumers' Association Ltd.), Harry Henry (McCann-Erickson Advertising Ltd.) and Professor H. W. Kuhn U.S. expert on operations research).

Technical and Industrial Appointments

(*Continued from preceding page*)

At the meeting of the board of **Richard Thomas and Baldwins Ltd.** recently, Sir Ernest Lever announced his intention of retiring from the chairmanship early in April, 1959.

The board elected Mr. Geoffrey C. R. Eley, C.B.E., to be a member of the board and appointed him to be an additional deputy chairman. It is their intention, on Sir Ernest Lever's retirement, to elect Mr. Eley to be chairman of the company.

* * *

Fielden Electronics Ltd. Wythenshawe, Manchester, have formed three new sales divisions : London, the North-East and the Midlands. Appointments recently made in these divisions are as follows :—

Mr. R. Speller, after three years as company representative in London North, becomes manager of the London sales division. Mr. F. G. Totty, formerly Yorkshire representative, becomes North Eastern sales division manager, based on Stockton. Mr. F. B. Price, for many years Fielden representative in the Midlands, assumes the management of the expanding Midlands sales division.

NEW COMPANIES

"Ltd" is understood, also "Private Co."
Figures = Capital, Names = Directors, all unless otherwise indicated.

Waite Bros. of Shipley, 93, Kirkgate, Shipley, Yorks. November 28. £5,000. To carry on bus. of painters, painting contractors, etc. Chas. G. Waite, Mrs. Leah Waite.

Hollingbury Finishes, 2, Marlborough Place, Brighton, 1. December 1. £2,000. To carry on bus. of paint spraying, stove enamelling etc. Sunya D. M. Leeson, Anne C. Still.

Cadmium (Liverpool), 68, Gloucester Street, Liverpool, 3. December 1. £1,000. To carry on bus. of cadmium platers, etc. Gordon S. Fraser.

James Jennings (Salford), 56, Peel Street, Salford, 6. December 2. £2,000. To carry on bus. of platers, electroplaters, etc. James Jennings and Hilda Jennings.

Tufchrome, Lenco Works, Old Walsall Road, Handsworth Wood, Birmingham, 22a. December 9. £5,000. To carry on bus. of chromium platers, etc. Wm. J. Clements and Maisie F. Clements.

From the Register compiled by Jordan & Sons Ltd, 16 Chancery Lane, London, W.C.2.

RETIREMENT OF SIR ERNEST CANNING

SIR Ernest R. Canning, D.L., J.P., chairman of the board of directors of W. Canning and Co. Ltd., has resigned from the board due to advancing years. Mr. F. R. Ewens, A.C.A., has been appointed chairman and joint managing director and Mr. W. H. Griffin, J.P., has been appointed joint managing director. Mr. B. Tromans, A.R.I.C., connected with the chemical division for 17 years has been elected a director. Sir Ernest has been with the business for 66 years and has been chairman of the board since the company's incorporation in 1920. In recognition, the directors have recommended an alteration to their articles of association to permit Sir Ernest becoming president of the company. Seen below, Sir Ernest (left) is congratulating Mr. Ewens.

LININGS FOR CHEMICAL PLANT

THE plant lining group of the Federation of British Rubber and Allied Manufacturers has set up a technical panel to consider the possibility of drawing up a code of practice for rubber and ebonite linings that customers can specify at the time of ordering and rely on as a guarantee of quality.

Members of the technical panel will be : J. Westhead, A.R.I.C., A.I.R.I., A.M.C.T., (B.T.R. Industries Ltd.) ; J. T. Hull, A.I.R.I., (Dexine Rubber Co. Ltd.) ; J. L. F. Crompton, A.I.R.I., (Dunlop Rubber Co. Ltd.) ; H. L. Malan, B.Sc., (Nordac Ltd.) ; H. Bridge, (Redferns (Bredbury) Ltd.) ; C. H. J. Avons, F.I.R.I., (St. Helens Cable and Rubber Co. Ltd.).

The panel say they will welcome suggestions from designers and fabricators of chemical plant on points that a code of practice might cover. Suggestions should be sent to the director of the Federation at 43, Bedford Square, London, W.C.1.

London Office for Wests

MR. J. A. Hartnett, managing director of West Instruments Ltd., manufacturers of temperature control equipment, says his company will open a London office in January.

Two area managers have been appointed, responsible for instrument sales and service in London and the Home Counties.

Mr. L. M. Collyer, B.Sc., who was formerly engaged on research for British Petroleum Ltd., is to be area manager for Central London, and the counties lying south and west of London. Mr. N. J. Riddett, B.Sc., formerly with Standard Telephones and Cables, where he was engaged on research into semi-conductors, is to be area manager for East Anglia, Middlesex, Herts, and Bedfordshire.

From January 1, it has been agreed that West sales and service will no longer be handled by Industrial Instruments Ltd., formerly the firm's London and Home Counties agents.

TRADE and TECHNICAL PUBLICATIONS

The use of aluminium for window frames has grown considerably over the past ten years for residential, industrial and school buildings. A new A.D.A. publication, addressed to architects and their clients, *Aluminium Windows*, describes aluminium window frame design and illustrates some of the many examples to be seen up and down the country today. Many of the window manufacturers have co-operated in the presentation of the book. In lieu of a British Standard on aluminium windows, the brochure should fill an important function and can be used as a basis of a code of practice.

The four main sections of the brochure deal with : types of aluminium windows, materials and methods, installation, weathering and maintenance.

In the notes on weathering and maintenance there is reference to B.S. 1615:1958 " Anodised Aluminium " which specifies various grades of anodic films for indoor and outdoor use ; and, in particular, to the specification notes for the colour anodising of aluminium for exterior use based on the requirements of B.S.1615. The notes also cover the choice of materials and are accompanied by a list of recommended dyes, illustrated in a colour chart also available from the Association. Price of the publication is 10s. 6d. and is available from the Association at 33, Grosvenor Street, London, W.1.

* * *

Ethylene diamine tetra-acetic acid is a compound with manifold industrial applications and in addition is a versatile analytical reagent. It is used in the estimation or purification of metals, in direct titration, as a masking agent, in increasing the sharpness of a separation, and in many other ways. *A Bibliography of the Analytical Uses of E.D.T.A.* covers literature published up to the beginning of 1958 in most countries of the world, including India, Japan and countries of Eastern Europe (much important work in this field has been done in Czechoslovakia). The entries are grouped according to the type of use.

E.D.T.A. and its derivatives are sold in Britain by The Geigy Co. Ltd. under the trade name " Sequesterol." Enquiries on all applications of the acid are invited from the development division, The Geigy Co. Ltd., Rhodes, Middleton, Manchester.

A publication, *Rocol Molybdenised Lubricants*, is probably the most complete guide yet published to the use of a vast range of molybdenised lubricants for industry.

The lubricants described have been developed by one of the pioneering firms in this field, Rocol Ltd., Rocol House, Swillington, nr. Leeds, who have developed and invented 28 specialised lubricants using molybdenum disulphide. An interesting application of one of these is in the permanent dry lubrication of atomic reactor control rod mechanisms, that, once installed, cannot be ' oiled ' again.

The publication explains the physical properties and commercial specification of the products.

* * *

" *Trisec for Rapid Metal Drying* " is the name of a booklet issued recently by Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1., to describe the company's new agent for the rapid drying of metal articles. Trisec is used as an additive to trichlorethylene to remove water quickly from treated articles in metal degreasing plants. Workpiece surfaces are left unstained and further wiping is unnecessary. The agent is intended to supersede systems that use centrifuges, sawdust or hot air, especially where these are followed by polishing or wiping to remove evaporation stains. Available free from the company on application.

* * *

A leaflet issued by the Shandon Scientific Co. Ltd., 6, Cromwell Place, London, S.W.7., gives brief details of the company's latest electropolisher that they claim has a unique method of dispersing the anodic layer resulting in complete freedom from flow lines. Easily operated by unskilled personnel, all materials in contact with the electrolyte are made from glass, p.v.c., polythene or high grade stainless steel.

A self-contained power supply designed for use with the polisher has controls for manual and automatic polishing and etching, with two separate D.C. circuits and a rheostatically controlled A.C. circuit The power unit can also be used for other work in the laboratory where a controlled and metered D.C. supply is required. The leaflet is available on application.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Automatic Voltage Controller

BURNING and uneven electro-plating is avoided with the "Davenset" automatic constant voltage controller. The voltage can be preset to a required value and will thereafter remain constant irrespective of variations in current. This voltage constancy is maintained irrespective of quite wide variations of the mains supply voltage and frequency.

The constant voltage control cubicle (Fig. 1 illustrates the control panel of this) can be situated remotely from the plating rectifier and plating bath, if necessary under lock and key to ensure that once the voltage for a particular plating run has been set interference by unauthorised persons is impossible.

The cubicle illustrated is for use with a 'Davenset' plating rectifier with maximum output of 16 volts, 250 amp. The voltage can be preset at any value between 8 and 16 volts, and will remain constant irrespective of variation in plating current from zero to 250 amps.

The controller is also available for use with existing plating rectifier installations.

The equipment is made by Partridge, Wilson and Co. Ltd., Davenset Works, Evington Valley Road, Leicester.

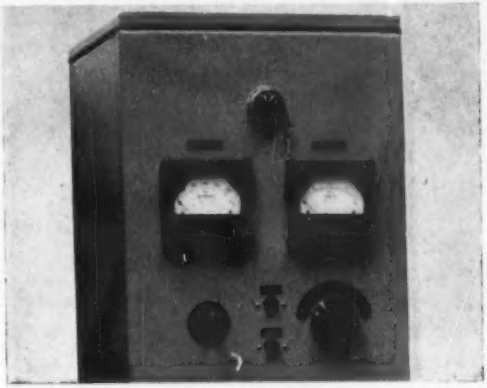


Fig. 1. — This A.V.C. for electroplating plant has a maximum output of 16 V.

Transparent Double-sided Tape

A NEW addition to their range of double-sided self-adhesive tapes (a transparent cellulose tape having adhesive both sides of the base material) was announced recently by John Gosheron and Co. Ltd., Vauxhall, London, S.E.11.

The double-sided tape has been developed to give an extremely thin, yet strong, mounting medium where surfaces have to be joined as closely as possible. Three base materials are now available — paper and cloth (in 50 yd. lengths) and cellulose (in 36 yd. lengths).

The tapes can be put to a variety of uses, for example, the securing of thin metals during grinding and polishing processes, and joining the ends of sheets or rolls of cloth or metal to give a continuous feed through stamping machinery. The makers say that experiments are under way for a similar application during tin or fabric printing processes.

Tha tapes are quick and easy to apply, conforming to most irregular surfaces, and provide a firm and tenacious join. Widths up to 12½ in. have been supplied.

Portable Solution Filter

A ROTATING magnetic field to drive the pump impeller eliminates the need for any seals or stuffing boxes on the new "Pre-met" solution filter introduced recently by Sel-Rex Corpn., Nutley, New Jersey. The innovation, the manufacturer claims, lessens the possibility of valuable solution loss in the filtration of precious metals solutions, and will also eliminate solution contamination by lubricants in the pharmaceutical biological and beverage industries.

The filter utilizes a canned turbine pump and motor unit continuously lubricated by the solution being pumped. The stainless steel filter tube contains an element of specially processed cotton or dynel yarn wound around a stainless steel supporting core. This "cartridge" filter element provides what the manufacturer calls "depth filtration" through numerous interlaced layers totalling 500 sq. in. per cartridge. The elements can be supplied to filter particles from 150 down to 1 micron sizes. In precious-metals plating-solution filtration, precious metals are fully reclaimed by simply igniting the inexpensive filter cartridge.

Flow rate is easily adjusted from zero to maximum by pinch valves, the pump motor unit will not overload and will use less power as flow diminishes. Filtration area can be increased in multiples of 500 sq. in. by attaching additional filter tubes. On multiple filter tube units, individual cartridges can be replaced without stopping filtering operations.

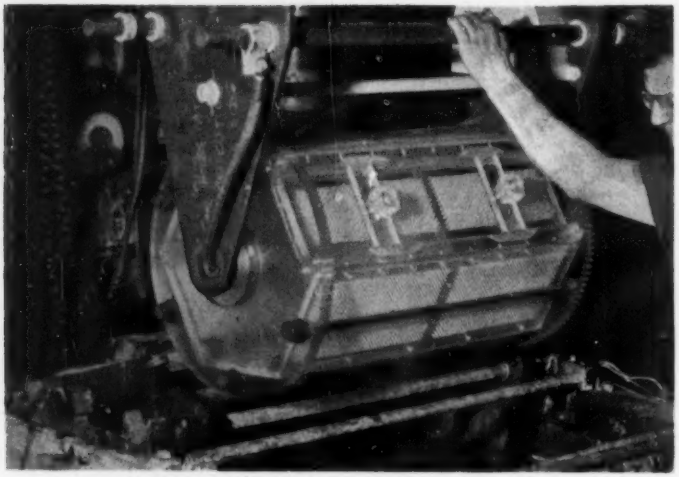


Fig. 2—A "Perspex" barrel can be used throughout the cleaning and plating cycle.

The simple functional design of the filters features a curved frame having an easy-grip handle for portability. Multiple filter tube units can be equipped with castors or rubber wheels, if desired.

British agents for Sel-Rex are M. L. Alkan Ltd., South Ruislip, Middx.

Pen-type Surface Marker

A CONTROLLED-FLOW pen-type marker having no moving parts, suitable for writing, marking, painting or stencilling on practically any kind of surface has recently been introduced by Ofrex Ltd., Ofrex House, Stephen Street, London, W.1.

The marker gives a completely controlled and even flow, maintained without the use of any valve mechanism inside the barrel. Refilling is clean and simple, giving a long writing charge. The advantages of the valveless construction are that the marker will not clog and is always ready for instant use, even after being left in a drawer or carried in a pocket for weeks without use.

Nibs of compressed felt have various shapes from fine to very broad and are charged with Ofrex "Rapidry" ink ; the drying action on application is almost instantaneous, but the ink cannot dry out in the pen, the makers say. The ink is obtainable in various colours.

Plastic Plating Barrel

THE EPE24 totally immersed hexagonal plating barrel illustrated in Fig. 2 has recently been introduced by Sonic Engineering and Equipment Ltd., 120-130, Parchmore Road, Thornton Heath, Surrey. It is made from ½-in. thick abrasion resistant Perspex joined by nylon screws. The bearings and intermediate drive gears are of resin laminated fabric ; the insulated tie-rods are the only steel parts employed, so that the barrel is resistant to pre-cleaning and plating solutions and can be used throughout the cleaning and plating cycle.

The replacement of any part is a simple process ; a damaged panel, for example, can be easily replaced since no cement or doughing is used in manufacture.

A quick release lid is fitted and perforations in the panels are made to suit the part to be plated : the model illustrated has a central partition to enable different sizes of parts to be plated at the same time, and the suspension arrangements can be modified to suit individual requirements. The overall length of this model is 24 in. and the dia. across the flats is 14½ in., giving a process load of up to 90 lb. The hangers are rubber covered so that no deposit build-up can take place. Barrel units can be supplied individually or with whatever types of tank and drive unit are required, such as individual plating units or complete cleaning, plating and rinsing units for large scale production.

Turning Head For Selective Plating

TO simplify their method of selective plating circular or cylindrical components, Dalic Metachemical Ltd., 121, Judge Road, Toronto 18, Ontario, Canada, in conjunction with Marlane Development Co., New York, and other Dalic process distributors are marketing a low-speed turning head as an optional accessory. (Fig. 3).

Fig. 3.—A low-speed turning head is useful for "selective-plating" cylindrical pieces

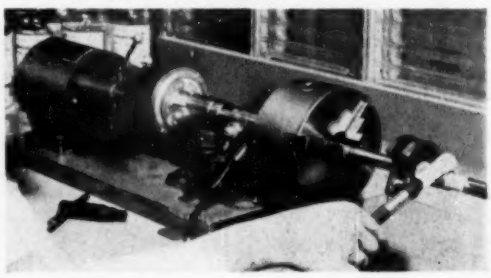
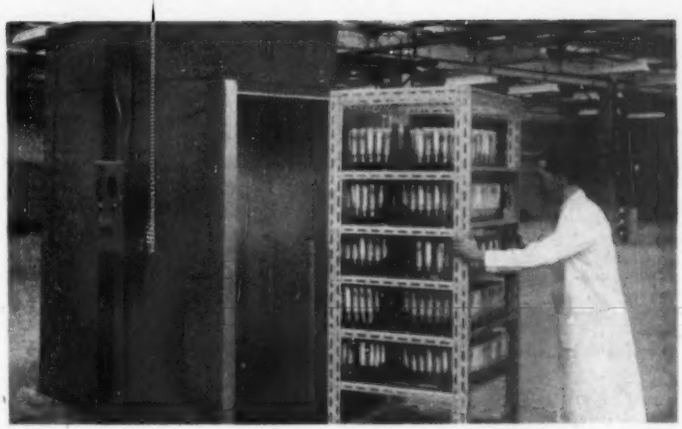


Fig. 4—Batch stoving of tubes in a "Funditor" oven



The head includes a variable speed control for infinite adjustment of rotation from zero to 400 r.p.m. in either direction. The correct tool-to-surface speed, depending on the plating solution being used, can easily be achieved, and Dalic says that the range of speeds has been selected to handle well over 90 per cent of the work normally plated by their method.

The new turning head is designed for round components such as shafts or housings, where a bearing surface may require build-up due to over-machining or excessive wear. Other applications are commutators or similar electrical components to be plated for longer wear and better conductivity. Cam surfaces, hexagonal cross-sections, etc. can also be handled, if their eccentricities or irregularities are not too severe,

The assembled unit includes a motor, 'Zero-Max" infinitely-variable speed control, "Tork-O-Stat" overload protector, two pillow blocks and a 3-jaw chuck. English agents are Metachemical Processes Ltd., 41-43 Gatwick Road, Crawley, Sussex.

Range of Stoving Ovens

THE range of ovens made by Funditor Ltd., Woodbridge House, 3, Woodbridge Street, London, E.C.3., includes several designed especially for stoving small parts on a production basis.

The model illustrated (Fig. 4) was constructed for the batch stoving of lacquered collapsible tubes and has interior dimensions of 7 ft. high x 3 ft. deep x 3½ ft. wide.

A centrifugal fan passes air through the ducting in the right-hand wall of the oven through the element chamber, which is sunk into the floor, and then into and through the oven. Process timers are fitted in the control panel and either vertical or horizontal air circulation is available. A special feature of the oven is the lightweight trolley to facilitate the quick and easy loading of charges.

Fig. 5—Test apparatus for surface coatings

Non-destructive Test Instrument for Metallic Coatings

THE "Elcotector" illustrated in Fig. 5 is an instrument designed to carry out a large number of measurements non-destructively. Its primary use, say the makers, is for all types of coating measurements on components, and in addition, for measuring the thickness of most metallic and non-metallic foils while stationary or moving. It can be applied to the production run to give continuous readings of thickness as material is produced. Makers of the instrument, the East Lancashire Chemical Co. Ltd., Fairfield, Manchester, give as examples of its capacities, the following :

It can measure any type of coating, metallic or otherwise, on a ferrous base ; measure metallic coatings on any metallic base provided the specific resistance of these are different ; compare the degree of hardness of steel components ; differentiate between the variations in ferrous contents in steel ; measure the thickness of non-ferrous foils ; measure any type of metallic and non-metallic film provided that with the latter a metal plate can be introduced at the reverse side at the point of measurement ; differentiate

(*Continued in page* 42)

Plant, Processes, etc.

(*Continued from page* 41)

between various types of alloys ; detect surface cracks.

The uses of the instruments are not limited to these examples, and the manufacturers are prepared to consider its application for other purposes.

The Elcotector, say the makers, is a new development of the use of the eddy current principle, and the difficulties experienced in applying this principle in the past have now been overcome.

The device makes use of the electrical characteristics of a coil being influenced by its proximity to a metallic surface. Under suitable conditions, a meter can translate these changes in the coil into measurements of non-metallic coatings on metal. The coil is also influenced by the type and structure of the metal, *i.e.* the changes can be translated into metallic film thickness, metal hardness and like measurements.

The Elcotector's coil is in the head of a probe, presented to the surface under test. Two types of probe are available—one, a short pencil for general purposes ; the other, a short head and angular extension for confined spaces, both being used in hand checking. For continuous strip measurement, special probes can be produced ; these can be housed in P.T.F.E. frictionless material, lightly balanced so as not to affect delicate material. Hollow cup or pot coils can be provided for repetitive hardness measurement of such small tools as drills, plug gauges, taps, steel balls, etc. The sensitivity of the unit varies according to the type of work and can be adjusted over very wide limits.

Dust Exclusion Method

THE barrier method of dust exclusion comprises screens of dust absorbing material to reduce to the minimum dust penetration in whole workshops, rooms or specific areas. The method has recently been introduced by Anti-Dust Services Ltd., Dudley, Worcs.

The material used is of open weave, impregnated with a non-drying adhesive that does not impede light or ventilation to any appreciable extent, the makers say. The support framing has been designed to allow for constructions up to 15 ft. wide and of any length, easily erected and dismantled, and completely rigid. It allows the use of existing lighting.

The method is already in use in car refinishing and other trades, where it offers a relatively cheap means of eliminating many of the dust problems encountered in the manufacturing and finishing processes, storage and packing. The life of the material is governed only by the amount of dust present and the impedence to light this causes.

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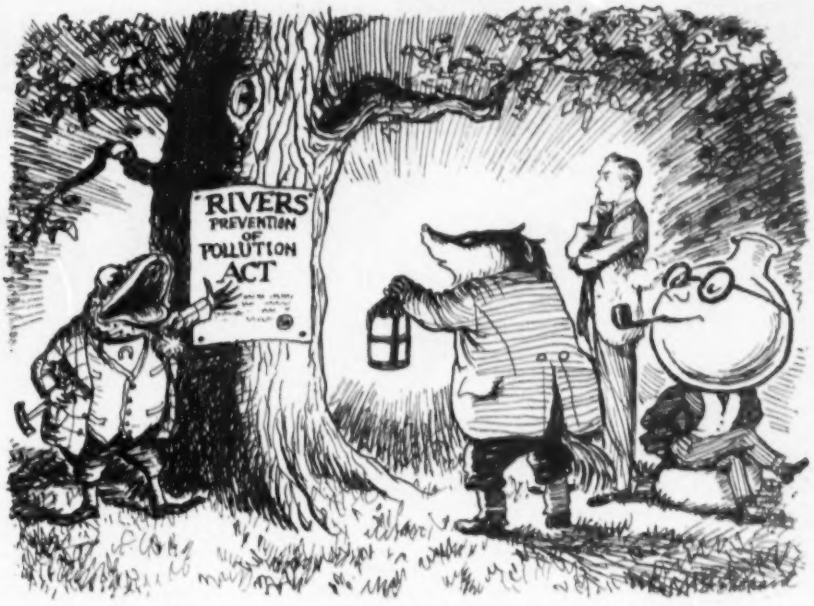

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WORKS MANAGER: I'll want full-scale trials.

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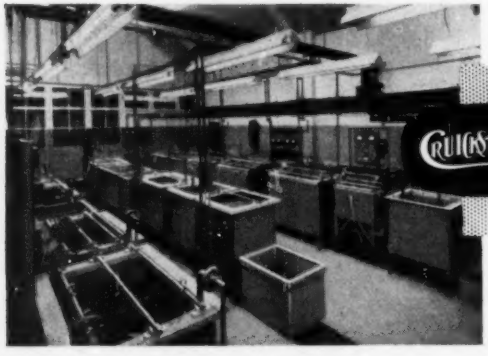

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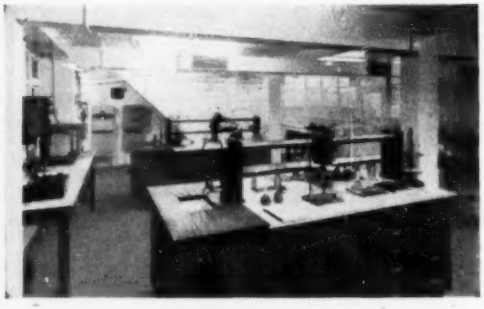

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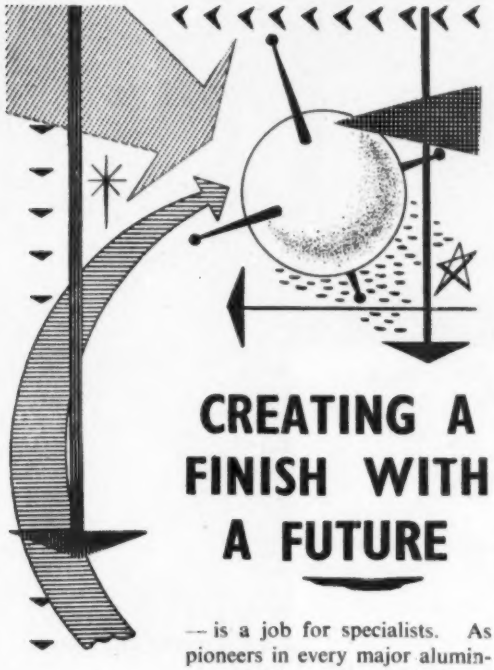

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INDEX TO ADVERTISERS

	Page		Page
Aerograph Co. Ltd.	12	Impregnated Diamond Products Ltd.	23
Albright & Wilson (Mfg.) Ltd.	6 & 7	Kemball, Bishop & Co., Ltd.	24
Alkan, M. L., Ltd.	17	Kerry's (Ultrasonics) Ltd.	22
Almco Ltd.	—	Laporte Titanium Ltd.	—
Alumilite & Alzak Ltd.	25	Lawton, Ralph, Ltd.	—
Anti-Dust Services Ltd.	—	Main Enamel Manufacturing Co. Ltd.	11
Ballard, F. J., & Co. Ltd.	—	Metals & Methods Ltd.	25
Bilston Shot & Grit Co. Ltd.	—	Midland Galvanizers Ltd.	—
Blythe Colour Works Ltd.	—	Minnesota Mining & Manufacturing Co. Ltd.	—
Borax & Chemicals Ltd.	26	Mond Nickel Co. Ltd. (The)	—
Borax Consolidated Ltd.	18	Morris, B. O., Ltd.	—
British Chrome & Chemicals Ltd.	27	Nu-Way Heating Plants Ltd.	10
British Paints Ltd.	—	Pascall Engineering Co. Ltd.	—
British Titan Products Co. Ltd.	—	Pye, W. G., & Co., Ltd.	13
Brotherton & Co. Ltd.	21	Pyrene Co. Ltd.	20
Canning W., & Co. Ltd.	3 & 14	Ray-Heet (Process Plant) Ltd.	—
Carrier Engineering Co. Ltd.	—	Richardson, R. J., & Sons Ltd.	—
Chemical Engineering Construction (Pensnett) Ltd.	—	Shell Chemical Co. Ltd.	—
Coated Strip Ltd.	16	Silvercrown Ltd.	—
Cruickshank, R., Ltd.	22	Sismey & Linforth Ltd.	—
Curran, Edward, Engineering Ltd.	—	Stordy Engineering Ltd.	9
Electro-Chemical Engineering Co. Ltd.	5	Stuart, Robert (London), Ltd	16
English Abrasives Corporation Ltd.	8	Summers, John, & Sons Ltd.	2
Escol Products Ltd.	28	T.C. Spray Finishing Systems	15
Ferro Enamels Ltd.	—	Thompson Bros. (Bilston) Ltd.	—
Funditor Ltd.	—	Ultrasonic Applications Ltd.	—
Gas Council	1	Union Oxide & Chemical Co. Ltd.	—
Glebe Mines Ltd.	—	Vokes Ltd.	—
Glostics Ltd.	23	Volspray Ltd.	—
Griffiths, A. E. (Smethwick), Ltd.	4	Wallace & Tiernan Ltd.	21
Hawley, John, & Co. (Walsall) Ltd.	25	Wengers Ltd.	24
Hot Dip Galvanizers Association	—	Zinc Alloy Rust-Proofing Co. Ltd.	—
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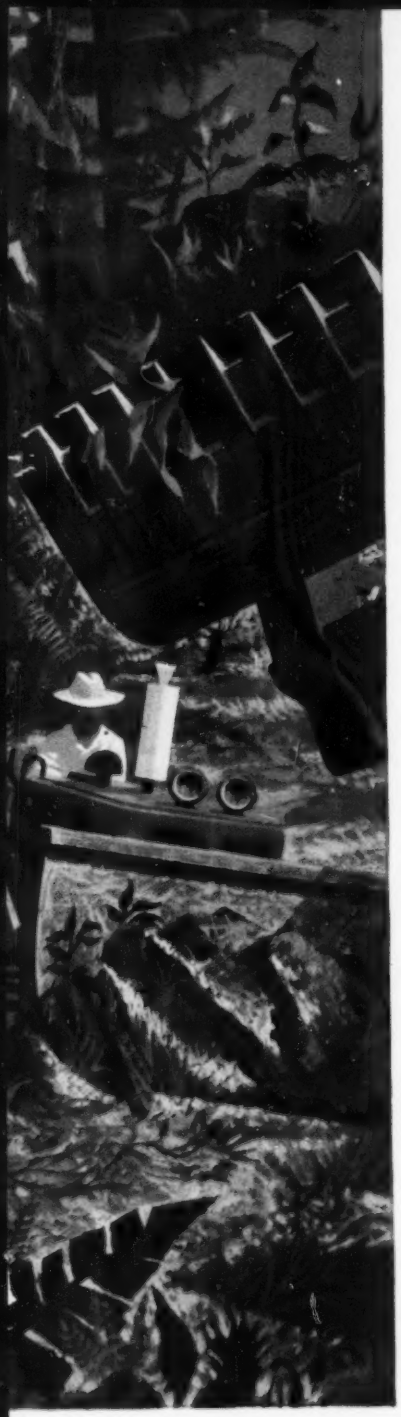

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